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OF THE

MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

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Alexander G. Ruthven
Director of the Museum of Zoology
University of Michigan

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NUMBER 62 DECEMBER 14, 1918

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

A MOUNTED SKELETON OF *EDAPHOSAURUS CRUCIGER* COPE, IN THE GEOLOGICAL COLLECTION OF THE UNIVERSITY OF MICHIGAN

BY E. C. CASE

In 1913 an expedition from the University of Michigan excavated the Brier Creek Bone Bed in Archer County, Texas, discovered the previous year. From this bone bed over fifteen hundred specimens, mostly of isolated bones, were recovered. From this large amount of material two skeletons have so far been restored showing the complete skeletal anatomy of the great lizard-like Permo-Carboniferous reptiles Dimetrodon (completed in 1915 and now in the Museum of Zoology of the University) and Edaphosaurus, just completed.

The genus Edaphosaurus has been one of the most puzzling forms of reptilian life of the late Paleozoic and the completion of a mount showing its characters is the final result of many collecting trips and trial mounts. The striking peculiarity of this form is the development of greatly elongated neural spines with prominent lateral projections on all the pre-sacral vertebrae. This peculiarity led to the identification of the first fragments of the spines as bits of petrified branches; later when their true nature was made out Cope described the animal as Naosaurus, the Ship-lizard, from the fancied resemblance of the cross-bars on the spines to the yard-arms of a ship. For a long time, when the skeleton was only imperfectly known, it was supposed that the animal was carnivorous in habit because of the general resemblance of the known bones to those of the carnivorous genus Dimetrodon with elongated, but smooth, spines. It was finally shown that the skull of a herbivorous or molluscivorous form previously described as Edaphosaurus really belonged with the cross-barred spines and the long used name Naosaurus was necessarily abandoned.

The skeleton as now mounted shows an animal with a relatively small skull provided with sharp conical teeth on the edges of the jaws and strong plates filled with blunt, crushing teeth on the dentary bones and the palate. The dorsal spines rise abruptly from just back of the skull to a considerable height and then curve back over the pelvic region. The sacral spines are abruptly shortened. The spines of all the precaudal vertebrae are provided with cross-bars. The lower pair are prominent and probably marked the upper limit of dorsal muscles; above this pair the cross-bars are rapidly reduced in size until above the center of the length of the spine they are reduced to knobs and lose the paired arrangement. The spines in the species *E. cruciger* terminate in blunt points. In other species of the same genus the shape of the spines and the size and arrangement of the cross-bars are notably different.

The animal possessed a broad scapula quite different in form from that of Dimetrodon. There is a small splint-like cleithrum, the clavicle is shorter and heavier than in Dimetrodon, the interclavicle has a stouter anterior end but a similar, elongate posterior projection. The humerus is quite like that of Dimetrodon in general form but possesses an ectepicondylar as well as an entepicondylar foramen. The lower arm bones are decidedly shorter and heavier than in Dimetrodon. The pelvis lacks the strong posterior prolongation of the ilium; instead, this bone is flared out into a broad, flat surface with a deeply grooved inner surface for cartilaginous attachment to the two sacral ribs. The femur has the bicipital groove extending further down the anterior face, bounded by strong ridges. The lower leg bones are short and heavy. No specimen has been found in which the feet are preserved and in the mount the feet are modeled after those of Dimetrodon. There is some reason to think that this is not correct and the arrangement is regarded as provisional. Certain very large and heavy claws found in the bone bed and in all probability not belonging to Dimetrodon may belong to Edaphosaurus. The ribs show that the animal had a fairly heavy body which was probably increased by the large size of the visceral cavity. That the tail was fairly long and provided with a distinct dorsal crest is shown by the neural spines, but the chevron bones were small and there is no indication of natatorial power.

The remains of this reptile are not uncommon in the Permo-Carboniferous deposits but the bones are mostly isolated and frequently water worn. It is believed that it lived upon higher land some distance from the lagoons and pools in the deposits of which the bones are found, and that the partially destroyed cadavers or isolated bones were transported to the place of burial and preservation by streams. The character of the teeth shows that the animal lived upon vegetation or hard-shelled molluscs which were crushed by the blunt teeth upon the palatal and dentary plates. The shortness of the lower limbs shows that the movements were slow, while the stoutness of the limb bones and girdles indicates great strength. The animal probably lived upon the upland eating hard vegetation or roots which it excavated with its powerful claws or haunted the banks of upland streams devouring vegetation and hard-shelled molluscs.

No rational explanation has been given for the enormous development of the neural spines upon a functional basis. It is the opinion of the author, elsewhere expressed, that the spines are a case of physiological overgrowth starting from smaller spines in some ancestral form in which they were of advantage. Living apart from the fierce carnivores of the time, Edaphosaurus had probably found some degree of isolation which permitted the spines once started to increase beyond any size which would have been useful to the individual. Despite the physiological burden of the exaggerated spines, the animals were for a time successful for not only do the remains occur in considerable quantity but they are found as widely distributed as Oklahoma, Texas, Pennsylvania, and Ohio.

In the reconstructed skeleton and in the restoration the animal is shown in a normal resting posture with the head only slightly raised, this seems more natural than in a previous reconstruction of the skeleton made at another institution where the animal is shown raised upon the limbs in an attitude which could only have been assumed by an unusual effort and maintained for only a very brief period.

PLATE I

Reconstruction of the skeleton of *Edaphosaurus cruciger* Cope. The skull is a plaster cast of the only known skull, the terminal caudal vertebrae and some of the ribs are restored in plaster. One-twelfth natural size.

Edaphosaurus cruciger Plate I

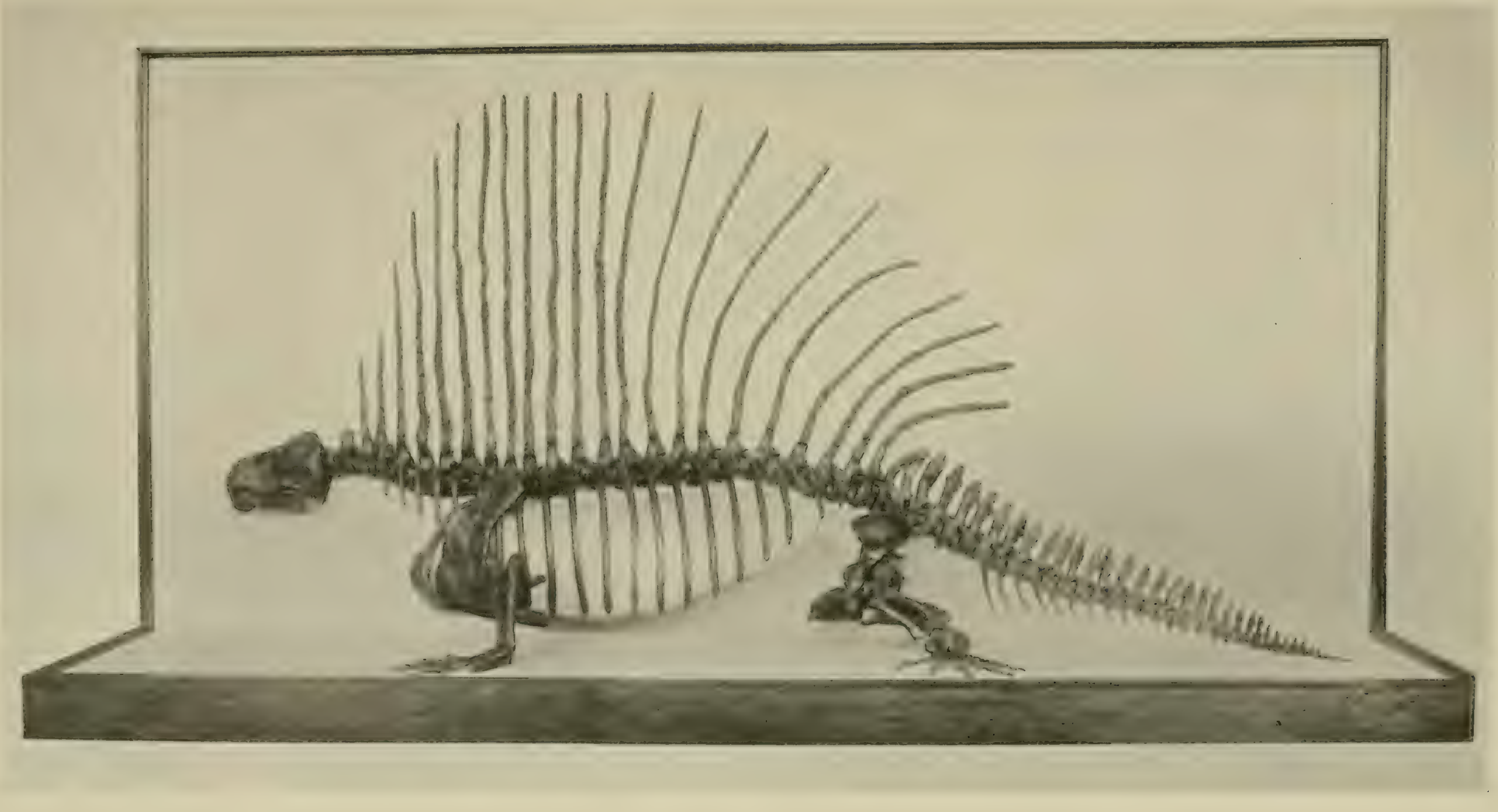
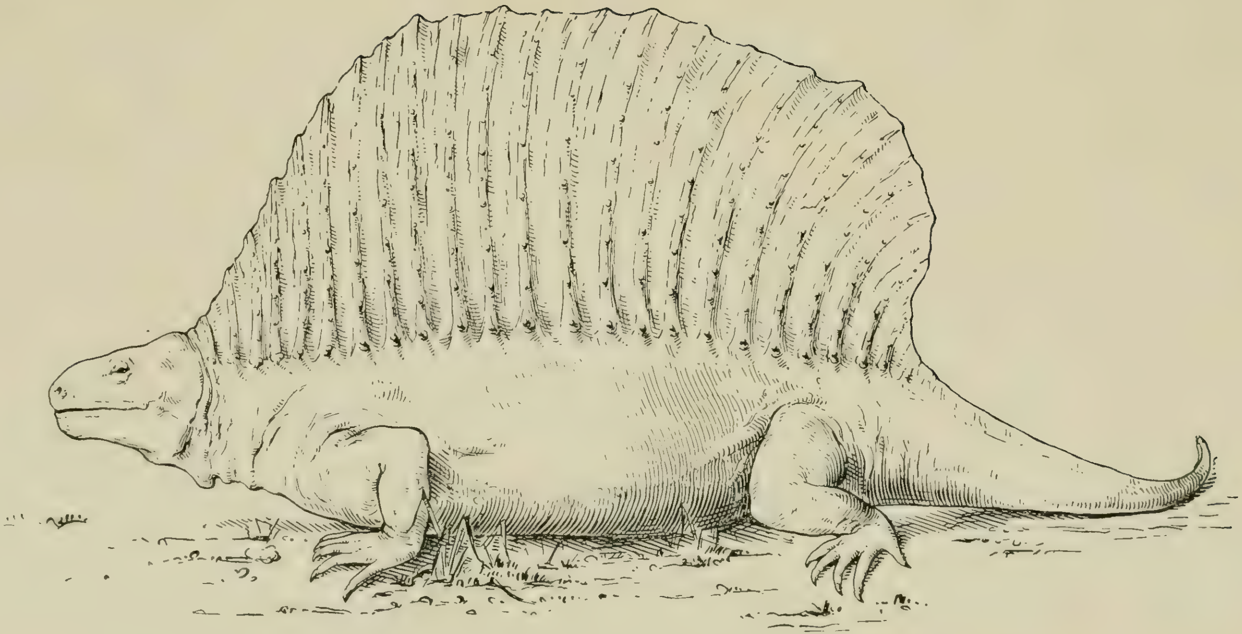


PLATE II

Restoration of *Edaphosaurus cruciger* Cope. One-twelfth natural size.

EDAPHOSAURUS CRUCIGER

PLATE II



NUMBER 63 JANUARY 5, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

RESULTS OF THE UNIVERSITY OF MICHIGAN-WILLIAMSON EXPEDITION TO COLOMBIA 1916-1917[1]

III. ARCHAEOGOMPHUS, A NEW GENUS OF DRAGON-FLIES (ODONATA)[2]

BY E. B. WILLIAMSON

In Occasional Papers of the Museum of Zoology, Number 59, June 24, 1918, I described a new dragonfly which, after some hesitation, was referred to the genus Agriogomphus, and the species was named *hamatus*. In that paper, page 3, I referred to the fact that I had written to Dr. Ris to have a photograph made of de Selys' type, if this were possible. Fortunately through the kindness of Mons. Severin and Dr. Ris I now have this photograph, and it is evident at once that the Agriogomphus of Needham, Ris and myself, has nothing to do with the true Agriogomphus of de Selys. The species referred to Agriogomphus by the three later authors above mentioned belong to an undescribed genus which I propose describing in this paper under the name ARCHAEOGOMPHUS, new genus, type *Agriogomphus hamatus* Williamson.

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[1] A Collecting Trip to Colombia, South America, Misc. Publ. Mus. of Zool., Univ. of Mich., No. 3, February, 1918.

[2] I, Occ. Papers, Mus. of Zool. No. 52; II, *l. c.*, No. 59

Archaeogomphus, new genus

Belonging to that group of genera (not necessarily closely related, *inter se*) of the legion Gomphus which possesses numerous unspecialized cross-veins between M_{1-3} and M_4. The distribution of characters within the group and the artificial key to the genera which I have previously published[3] should be revised, since Agriogomphus as used in that paper is really Archaeogomphus, and the characters of the true Agriogomphus are not included therein.

Distribution of Characters Within the Group

1. Stigma with a weak brace-vein: *Agriogomphus, Cyanogomphus, Ischnogomphus.*

1a. Stigma without a brace-vein: *Archaeogomphus, Epigomphus, Leptogomphus, Macrogomphus, Microgomphus.*

2. Basal antenodal of second series present: *Agriogomphus, Cyanogomphus, Epigomphus, Ischnogomphus, Leptogomphus, Macrogomphus.*

2a. Basal antenodal of second series not present: *Archaeogomphus, Leptogomphus, Microgomphus.*

3. Distal thickened antenodal the fifth: *Archaeogomphus, Agriogomphus, Cyanogomphus, Ischnogomphus, Microgomphus.*

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[3] Occasional Papers of the Museum of Zoology, University of Michigan, Number 52, April 17, 1918.

3a. Distal thickened antenodal the sixth or more distal: *Epigomphus, Leptogomphus, Macrogomphus.*

4. One cubito-anal cross-vein in addition to the inner side of the subtriangle: *Archaeogomphus, Agriogomphus, Cyanogomphus, Ischnogomphus, Leptogomphus, Macrogomphus, Microgomphus.*

4a. Two cubito-anal cross-veins in addition to the inner side of the subtriangle: *Agriogomphus, Epigomphus, Macrogomphus, Microgomphus.*

5. One row of postrigonal cells in the front wings: *Archaeogomphus, Agriogomphus.*

5a. Two rows of postrigonal cells in the front wings: *Cyanogomphus, Epigomphus, Ischnogomphus, Leptogomphus, Macrogomphus, Microgomphus.*

6. One row of postrigonal cells in the hind wings: *Archaeogomphus, Agriogomphus, Cyanogomphus, Epigomphus.*

6a. Two rows of postrigonal cells in the hind wings: *Cyanogomphus, Epigomphus, Ischnogomphus, Leptogomphus, Macrogomphus, Microgomphus.*

7. Anal area of the front wings one cell wide: *Archaeogomphus, Agriogomphus, Ischnogomphus, Microgomphus.*

7a. Anal area of the front wings two or more cells wide: *Cyanogomphus, Epigomphus, Leptogomphus, Macrogomphus.*

8. Two postanal cells in the hind wings: *Archaeogomphus, Agriogomphus, Cyanogomphus, Ischnogomphus, Microgomphus.*

8a. Three postanal cells in the hind wings: *Cyanogomphus, Epigomphus, Leptogomphus.*

8b. Four postanal cells in the hind wings: *Leptogomphus, Macrogomphus.*

9. Anal area in the hind wings, distal to the postanal cells, two cells wide: *Archaeogomphus, Agriogomphus, Cyanogomphus, Ischnogomphus, Microgomphus.*

9a. Anal area in the hind wings, distal to the postanal cells, three cells wide: *Epigomphus, Cyanogomphus, Leptogomphus.*

9b. Anal area in the hind wings, distal to the postanal cells, four or more cells wide: *Macrogomphus.*

10. Anal triangle present in the male: *Cyanogomphus, Leptogomphus, Macrogomphus.*

10a. Anal triangle not present in the male: *Archaeogomphus, Epigomphus, Ischnogomphus, Microgomphus.*

10b. Male not known: *Agriogomphus.*

An Artificial Key to the Genera of the Group

a. Basal antenodal of second series not present.
  b. One row of postrigonal cells in the front wings...... .... *Archaeogomphus.*
  bb. Two rows of postrigonal cells in the front wings.
    c. Anal area in the front wings one cell wide, in the hind wings two cells wide........*Microgomphus.*
    cc. Anal area in the front wings two or more cells wide, in the hind wings three cells wide..*Leptogomphus.*
aa. Basal antenodal of second series present.
  b. Anal area in the front wings one cell wide.
    c. One row of postrigonal cells in both front and hind wings .... *Agriogomphus.*
    cc. Two rows of postrigonal cells in both front and hind wings ....*Ischnogomphus.*
  bb. Anal area in the front wings two or more cells wide.
    c. Distal thickened antenodal the fifth.*Cyanogomphus.*
    cc. Distal thickened antenodal the sixth or more distal.

d. Anal area in the hind wings three cells wide.
e. One cubito-anal cross-vein in addition to the inner side of the subtriangle. . .*Leptogomphus.*
ee. Two cubito-anal cross-veins in addition to the inner side of the subtriangle. . . . .*Epigomphus.*
dd. Anal area in the hind wings four or more cells wide . . . . *Macrogomphus.*

Archaeogomphus is an isolated type without apparent relationships. The strikingly unsymmetrical forking of $M_{1\,2}$ and M_3, which occurs also in Leptogomphus and Microgomphus of the Oriental fauna and Epigomphus of the Neotropical, is found scarcely or not at all in other genera of the legion Gomphus, a symmetrical or nearly symmetrical forking being the rule. The male of the type species, *hamatus,* is unique in the form of the tenth abdominal segment; this has the dorsum armed basally on either side with a strong interno-posteriorly directed hook and produced apically in a long snout-like projection which is more than twice as long as the rudimentary, flap-like, superior appendages; the inferior appendage is still more rudimentary, and these appendages have no function as grasping organs. *Agriogomphus infans* Ris is an Archaeogomphus; and Needham's figure 27, in A Geneologic Study of Dragon-fly Wing Venation, is of an undescribed species of the same genus.

The venation of *Archaeogomphus hamatus* is figured in my paper describing the species (Occ. Papers of the Mus. of Zool., No. 59). In that paper on page 11, first line, for *two-thirds* read *two-fifths;* and in the explanation of Plate I, first line, insert *lowest* after *10* and before *magnification.*

Agriogomphus is closely related to Cyanogomphus and Ischnogomphus, from both of which it is separated at once by the more reduced venation. In the photograph of the wings (Plate I) there is a single cubito-anal cross-vein in addition to the inner side of the subtriangle in the right wings, but in the left wings there are distinctly two in the hind wings, and probably two in the front wings.

PLATE I

Figure 1. Wing photograph of *Agriogomphus sylvicola* Selys, one of the two females on which the descriptions of both genus and species were based. Through the kindness of Mons. Severin, who made the photograph at the request of Dr. Ris, the following data are available: The two specimens of this species are under a green label written by de Selys "*Agriogomphus sylvicola* Bates." The specimen photographed has a small white label "St. Paula" in an unknown hand, and a larger white label "*Agriogomphus sylvicola* Bates, female" in de Selys' hand.

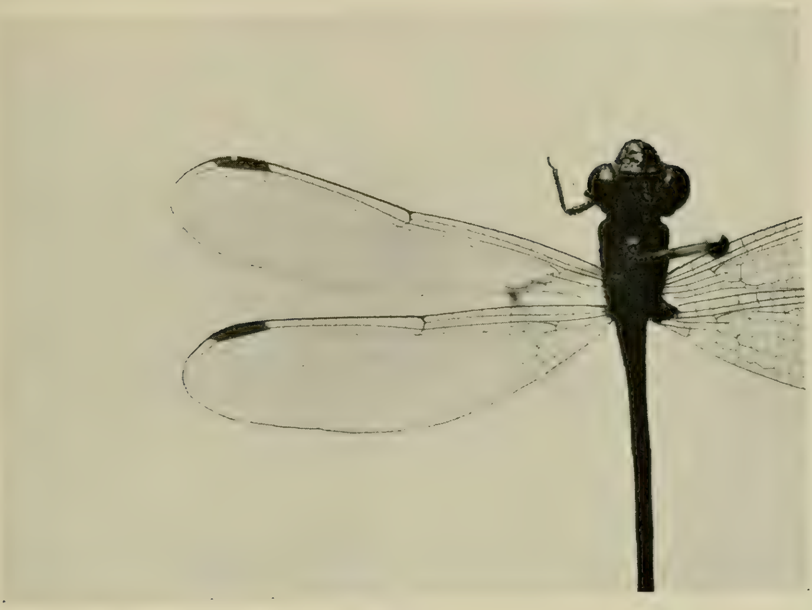
~~PLATE II~~

Figure 2. Male accessory genitalia of *Archaeogomphus hamatus,* Fundacion, Colombia, January 10, 1917.

The striking characteristics of the penis are its relatively weak chitinization, and its great complexity, especially of the second segment. The ventral process or spur of this segment is, in *Archaeogomphus hamatus,* like a broad shovel, being fully as wide as the wide second segment. Its attachment to the second segment is in the shape of a low capital T, the cross of the T being basal. The apex and the three borders of the broad spur are well chitinized but the enclosed parts are progressively less chitinized toward the point of attachment, so only the extremities of the T-shaped base are well chitinized, the foot of the stem of the T (the apical extremity of the attachment) being most strongly chitinized. On either side of the stem of the T and almost parallel to it (slightly divergent) there is a thin expanded membrane, like a curtain, triangular in shape, attached to the second segment, with the distal edge free.

The distal median portion of the second segment is not chitinized, being a membranous expansion between the chitinized basal and lateral areas. From this membranous floor on either side rises a thin blade-like chitinized process or spine. The segment is terminated on the same surface by two thin curved chitinized flaps, joined and more or less margined with the usual thin membrane.

The dorsal and ventral basal surfaces of the third segment have each a similar thin membranous extension, which in each case has a free distal edge.



Fgure 1

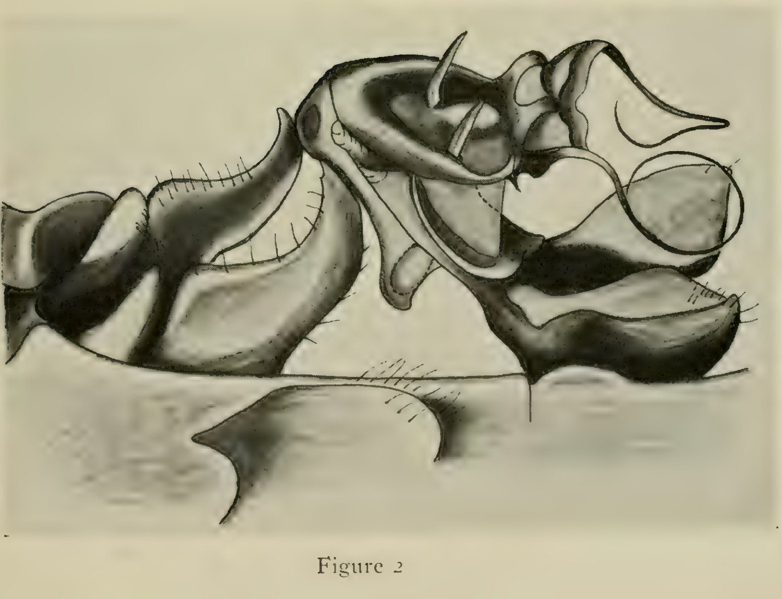


Figure 2

NUMBER 64 MARCH 17, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

A NEW SPECIES OF CAMPTOCERAS

By Bryant Walker

Camptoceras hirasei, new species

Pl. I, figs. 1-8

Shell sinistral, very slender, aciculate, horn-colored; whorls 3½, flattened laterally, strongly carinated above and below, separated by a broad, deep, concave channel, apical whorl bluntly pointed, bullet-shaped, reticulated by exceedingly fine lines of growth and spiral striæ, on the succeeding whorls the longitudinal striæ increase in size to a maximum on the body-whorl, while the spiral lines become more or less obsolete and are scarcely, if at all, visible on the body-whorl; aperture solute, elongate oval, narrow, somewhat wider below, angled above and below; lip continuous, the peritreme being slightly thickened and a little reflected on the lower, inner margin.

Length 7.25; diam. 2; aperture, length 3.5, diam. 1.5 mm.

Type Locality: Near Osaka, Prov. Kawachi, Japan.

Types: No. 38965 Coll. Walker. Cotypes in the collections Y. Hirase; Acad. of Nat. Sci. Philadelphia; U. S. Nat. Museum and Museum of Zool., Univ. of Mich.

Compared with *C. terebra* Bens., the only one of the Indian species which it at all resembles, and of which I have three specimens before me, *C. hirasei* is longer, narrower, the aperture less oblique to the axis, the longitudinal striation is more developed and the spiral lines less conspicuous.

This most interesting discovery of Mr. Hirase was made several years ago and the specific description has been delayed by the desire to obtain alcoholic material so that the systematic position of the genus might, if possible, be determined.

Camptoceras has hitherto been known by three species, all from India, and its unexpected occurrence in Japan widely extends its range.

The systematic position of the genus has been the subject of very diverse opinions. Benson, who discovered the typical species, gave a brief description of the external appearance of the animal and compared it with and distinguished it from Lymnæa. Nevill, according to Gude, was of the opinion "that it would prove to be a sinistral form closely allied to Succinea." Chenu placed it near Physa and Fischer did likewise, remarking (Man. Con., p. 511) that, if the eyes, as stated by Benson, were placed at the base of the tentacles, it could not possibly be a terrestrial species. Gude, on the other hand (Fauna Brit. India, Moll. II, 1914, p. 460), followed Nevill and retained it in the family Succineidæ.

Camptoceras hirasei occurs abundantly in Osaka and has been bred in Mr. Hirase's aquarium, so that Benson's original opinion as to its fluviatile character has been demonstrated. Figure 3, drawn from the living animal by Mr. Hirase's artist, shows the characteristic features of an aquatic species.

The alcoholic material, when received from Mr. Hirase, was sent to Mr. W. F. Clapp of the Museum of Comparative Zoology, Cambridge, Mass., for examination. Unfortunately it was not sufficient in quantity to enable a complete and detailed study of the soft anatomy. But the results obtained go far towards determining the probable systematic position of the genus. I am indebted to Mr. Clapp for the mounting of the radula figured and the drawings of the soft parts, except Fig. 3. The figure of the radula was drawn by Mr. J. H. Blake of West Somerville, Mass., and those of the shell by Miss Mina L. Winslow of the Museum of Zoology of the University of Michigan.

The radula (fig. 6) has a bicuspid central tooth, six bicuspid laterals, followed by five teeth, intermediate in character, in that the outer cusp gradually diminishes in size and one or more small additional cusps appear, and which gradually merge into the five marginals having a large inner cusp and, progressively, more numerous and small outer cusps; the bases of all of the teeth are quadrate, being nearly square in the central tooth and widening towards the margin.

The jaw (fig. 7) is composed of a long, slightly arcuate central plate with two lateral accessory plates.

The external appearance of the head of the animal is shown by fig. 4 from an adult specimen and fig. 5 from an immature one.

Mr. Clapp writes in reference to his figures:—

"I did succeed, however, in finding what I suppose to be the jaw and enclose a camera lucida sketch (fig. 5) of its position in the animal. In the figure, which is made from above, "a" is the mantle covering the entire animal, thin, delicate and transparent, excepting at the outer circumference, where it is considerably thickened. Through this can be seen ("b") the tentacles and very clearly ("c") the jet-black eyes at the inner base of the tentacles. The pigmented oval spot midway between the base and tip of the tentacles seen in every specimen of Camptoceras sent to me by you (fig. 4) is entirely lacking in this lot (received directly from Mr. Hirase), leading me to believe it is a character not acquired until the animal is nearly or quite mature.* "d" is the head, divided in two large, overhanging lobes, "e" is the foot. At "f" is a very puzzling character, which I at first thought, from its position, to be a part of the nervous system. It appears to be a band of membraneous tissue, stained with black, deeply imbedded in the animal. "g" is the jaw, an extremely minute, fragile, chitinous band, of which I have attempted to make an enlarged sketch (fig. 7). Its position is far posterior to where one would expect it to be. I have managed to dissect and mount the tube containing this jaw and radula in position and enclose a camera lucida sketch of the result in an endeavor to show the relative position of the two (fig. 8). The plate (fig. 7, g) is dorsal and much stronger with a noticeably curved cutting edge. The two accessory plates (fig. 7, g′) are ventral and, while nearly as large, are lighter colored and transparent. The containing wall (fig. 8, j) is distorted and ruptured by the slight pressure of the cover glass at the posterior end and in the region of the radula "I." "h" is the bent over, anterior end of the radula. Fig. 7 is an enlarged sketch of the jaw. I don't know whether the accessory plates are really attached to the dorsal plate or not.

---

* In a previous letter referring to fig. 4, he says:—"They (the eyes) are at the inner base of the tentacles. The black pigmented spot on the tentacles occurred in all four of the specimens I dissected. It is a fact that the eyes and tentacles and large, oval, pigmented spots on the tentacles are exactly the same in Ancylus as in Camptoceras."

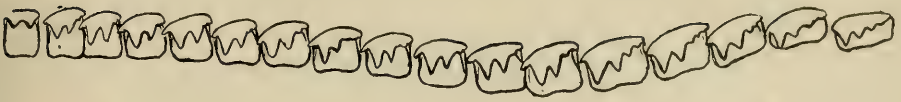
"In the drawing of Camptoceras I sent to you before (fig. 4) to show the position of the eye, the bulge behind the left tentacle is *not* the eye, but a mystery to me. It has no connection with the eye, but has some connection with the reproductive organs."

It is evident from these figures that Camptoceras does not belong to the Physidæ. The essential characters of the radula with its bicuspid central and the jaw with its accessory plates show quite conclusively that it belongs to the Planorbidæ and should probably be placed near to Isidora. The lack of pectinate or serriform marginals which are present in that genus according to Jickeli (Fauna N.-O.-Afrika, 1874, pp. 194 *et seq.*), Cooke (P. Z. S., 1889, 136), von Martens (S. und B. Moll. Ind. Arch., 1897, p. 8), and Sarasin (Sussw. Moll. Celebes, 1898, p. 19), separate it radically from that group. Standing alone, the radula is not unlike that of some of the Ancylidæ, but the shape of the shell and the character of the jaw prevents any association with any of the groups in that family having a somewhat similar radula. The fact that Lanx, usually included in the Ancylidæ, has a similar jaw should be mentioned, but that genus has the serrate marginals characteristic of the Lymnæidæ and quite probably should be entirely removed from the Ancylidæ.

PLATE I

Figure 1.	Dorsal view of the shell.
Figure 2.	Anterior view of the shell.
Figure 3.	Animal from beneath.
Figure 4.	Head of adult animal.
Figure 5.	Head of immature animal.
Figure 6.	Radula.
Figure 7.	Jaw.
Figure 8.	Buccal mass.

CAMPTOCERAS HIRASEI PLATE I



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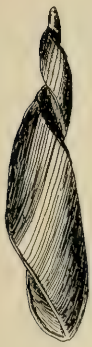

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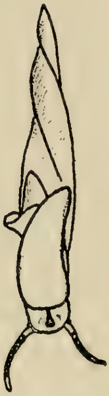

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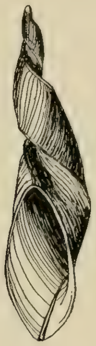

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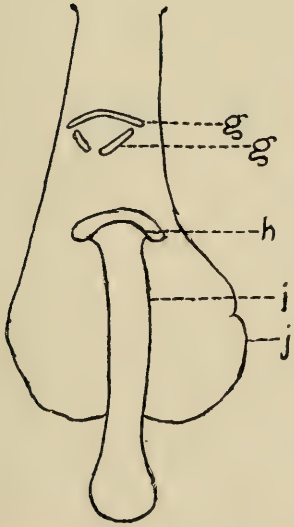

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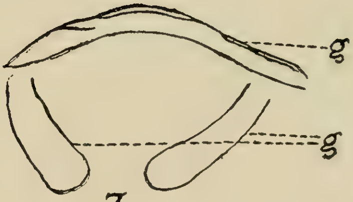

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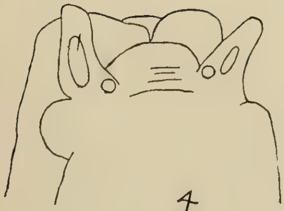

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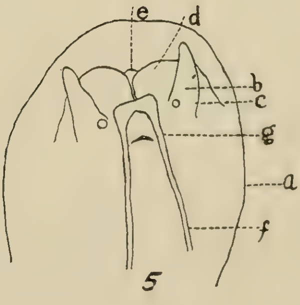

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NUMBER 65 APRIL 18, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

NOMENCLATURAL NOTES ON THE COTTOID FISHES OF MICHIGAN

BY CARL L. HUBBS

The present paper deals with the five species of Cottus, or fresh water sculpins, which inhabit the streams and lakes of Michigan, and the adjacent Great Lakes. The conclusions arrived at in the course of the investigation necessitate the proposal of several changes in the classification and nomenclature of each species.

The writer wishes to thank Mr. T. L. Hankinson for the loan of specimens of *C. franklinii* and *C. ricei*.

GENUS COTTUS LINNAEUS

Cottus Linnæus, Syst. Nat., Ed. 10, 1758, p. 264; Girard, Smiths. Contr. Knowl., 3, 1851, p. 33; Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1941; Kendall, Bull. U. S. Fish Comm., 22, 1902 (1904), p. 362; Gill, Smiths. Misc. Coll., 52, 1908, p. 114.

Logotype,—*Cottus gobio* Linnaeus.

Uranidea DeKay, New York Fauna, Fishes, 1842, p. 61; Jordan and Gilbert, Bull. U. S. Nat. Mus., 16, 1883, p. 693; Jordan and Evermann, *ibid.*, 47, pt. 2, 1898, p. 1963.

Haplotype,—*Uranidea quiescens* DeKay (=*Cottus gracilis* Heckel).

Cottopsis Girard, Proc. Boston Soc. Nat. Hist., 3, 1850, p. 303; Smiths. Contr. Knowl., 3, 1851, p. 61.

Orthotype,—*Cottus asper* Richardson.

Potamocottus Gill, Proc. Boston Soc. Nat. Hist., 8, 1861, p. 40.

Logotype,—*Cottus punctulatus* Gill.

Tauridea Jordan and Rice, Man. Vert. E. U. S., Ed. 2, 1878, p. 255.

Orthotype,—*Cottopsis ricei* Nelson.

With the exception of *Cottus* (*Tauridea*) *ricei* of the Great Lakes, the numerous American species of Cottus apparently present no characters by which they may be satisfactorily grouped either generically or subgenerically. Two characters have been so used by authors in general: the development of palatine teeth, and the number of rays in the pelvic fin. These two features are correlated neither with each other nor with other characters, and both vary widely within obviously specific limits. Consequently it appears that these characters are not of the kind that prove of value in the distinction of natural groups.

The palatine teeth vary widely, not only specifically, but intraspecifically as well. In fact in several species these teeth may be either present or absent. For example in *Cottus asper* the palatine teeth, though usually well developed, are occasionally obsolete.[1] This species is the genotype of Cottopsis Girard, a group based solely on the development of palatine teeth.[2] In other cases the teeth on the palatines are occasionally developed in those species in which the teeth are normally lacking.

The number of pelvic fin rays varies in *Cottus gracilis*, as both Kendall and Gill have indicated (*l. c.*). Consequently both of these authors have united Uranidea with Cottus, as the only character known to distinguish these nominal genera is the number of pelvic rays (I, 4 in Cottus; I, 3 in Uranidea). Snyder[3] has called attention to the occasional loss of the fourth soft pelvic ray of *Cottus punctulatus*. Similarly in *Cottus franklinii* (*q. v.*) the fourth ray, although normally lacking, is developed as a rare variation. This lack of constancy in the number of pelvic rays, involving an intraspecific variation which is identical with that used in distinguishing Uranidea from Cottus, indicates that this group is not a natural unit, the fourth soft pelvic ray having probably been independently lost in several cases. Confirming this supposition, the species having but three soft pelvic rays occur in three separated regions: from New England to Labrador and the Great Lakes, in the streams of northwestern United States, and in Japan.

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[1] Snyder, Bull. U. S. Bur. Fish., 27, 1907 (1908), p. 184.

[2] Potamocottus Gill is also based upon species with palatine teeth. The earlier but inapplicable name Pegedictis Rafinesque (see Gill. *l. c.*), sometimes altered to the correct orthography Pegedichthys, has been used by some authors, including Jordan and Evermann (*l. c.*), to designate those species having no palatine teeth.

KEY TO THE SPECIES OF COTTUS INHABITING THE WATERS OF MICHIGAN

*a.*¹—Preopercular spine short and little curved; head broadly rounded in outline; lateral line normally terminating below base of second dorsal.

  *b.*¹—Pelvic rays constantly I, 4; palatine teeth normally present.

    *c.*¹—Distance from anus to tip of snout when measured backward extending to a point nearer base than end of caudal; body rather robust; dark bars definitely developed ....*meridionalis.*

    *c.*²—Distance from anus to tip of snout when measured backward extending to a point nearer end than base of caudal; body rather slenderer; dark bars less distinctly developed ....*bairdii.*

  *b.*²—Pelvic rays usually I, 3; no palatine teeth; distance from anus to tip of snout, when measured backward, extending to a point nearer base than edge of caudal; dark bars of body not very distinctly developed.

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[3] Bull. U. S. Bur. Fish., 37, 1907 (1908), p. 101 and footnote.

c.[1]—First dorsal lower, only about half as high as second; pectoral longer, usually reaching beyond origin of anal; body usually more slender .... *gracilis.*

c.[2]—First dorsal higher, about two-thirds or three-fourths as high as second; pectoral shorter, reaching not, or barely, to origin of anal; body usually less slender................*franklinii.*

a.[2]—Preopercular spine long (as long as eye) and spirally curved; head subspatulate in outline when viewed from above; lateral line complete; no palatine teeth ....*ricei.*

Cottus meridionalis Girard

Cottus meridionalis Girard, Proc. Am. Ass. Adv. Sci., 2, 1850, p. 410; Proc. Boston Soc. Nat. Hist., 3, 1850, p. 189; Smiths. Contr. Knowl., 3, 1851, p. 47, pl. 1, figs. 9, 10.

Cottus alvordii Girard, Smiths. Contr. Knowl., 3, 1851, p. 46, pl. 1, figs. 7, 8.

Uranidea splilota Cope, Proc. Acad. Nat. Sci. Phila., 1865, p. 82.

Cottus spilotus Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1961.

Cottus ictalops Jordan and Evermann, *l. c.,* 1898, p. 1950 (in part); Fowler, Occ. Pap. Mus. Zool. Univ. Mich., No. 60, 1918, p. 49, pl. 13.

Cottus richardsonii Gill, Smiths. Misc. Coll., 52, 1908, p. 114 (in part).

This species is fairly common in the streams of southern Michigan.

As Dr. Gill (*l. c.*) has insisted, Rafinesque's name *ictalops* apparently is not applicable to this or any other cottoid species. *Pegedictis ictalops* Rafinesque was probably based upon one of the Etheostomatinae.

Study of material from various localities in the Mississippi Valley has shown that the characters used by Girard to differentiate *alvordii* from *meridionalis* are not constant, and hence not of taxonomic significance. The number of fin rays varies widely in this species, as illustrated by the following counts of anal rays in specimens in the Field Museum of Natural History.

Variation in the Number of Anal Rays in Cottus meridionalis

Locality	Anal rays					
	10	11	12	13	14	15
Illinois: Lockport and Joliet	—	—	1	6	5	1
Indiana: Ft. Wayne	—	1	2	5	2	—
Indiana: Cherry Creek	—	8	18	1	—	—
Missouri: Several localities	1	2	7	8	—	—
Arkansas: Batesville	—	—	—	7	—	—
Alabama: Florence	—	2	7	6	—	—

Cottus bairdii Girard

Cottus richardsonii Agassiz, Lake Superior, 1850, p. 300; Girard, Smiths Contr. Knowl., 3, 1851, p. 39, pl. 1, figs. 1, 2. (Not *Trachidermis richardsonii* Heckel, 1840, also a species of Cottus, synonomous with *Cottus asper* Richardson, 1836.)

Cottus bairdii Girard, Proc. Am. Ass. Adv. Sci., 2, 1850, p. 410; Proc. Boston Soc. Nat. Hist., 3, 1850, p. 189; Smiths. Contr. Knowl., 3, 1851, p. 44, pl. 1, figs. 5, 6.

Cottus wilsonii Girard, Smiths. Contr. Knowl., 3, 1851, p. 42, pl. 1, figs. 3, 4.

Cottus ictalops Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1951 (in part; apparently not *Pegedictis ictalops* Rafinesque).

This species or subspecies seems to be a northern form of *Cottus meridionalis.* It occurs with (or near) *Cottus gracilis* or its representative, *C. franklinii,* in the upper Ohio basin; in Cayuga Lake, New York; in Lake Superior; and probably in intervening localities. Specimens in the Field Museum of Natural History, referable to *Cottus bairdii,* were taken in Cayuga Lake, New York, and at Sault Ste. Marie and Lizard Islands, Lake Superior. Like Girard's specimens, which he referred to *richardsonii, bairdii* and *wilsonii,* those at hand have the anus more posterior than in *Cottus meridionalis.*

One of the diagnostic features of *C. wilsonii* as defined by Girard, is the branching of the pectoral rays. In the series from Cayuga Lake, agreeing in most details with Girard's description and figure of *wilsonii,* one specimen has two pectoral rays, another but one ray, branched on each side; the other five specimens of the same lot have all the rays simple. This occasional branching of the pectoral rays is not confined to this species however, for a large example of *Cottus meridionalis* from Joliet, Illinois, has some pectoral rays branched, three on one side, one on the other.

In comparing Lake Superior and Cayuga Lake material, certain average differences were noted. In the Lake Superior specimens the vertical of the greatest depth usually passes before rather than behind the origin of the first dorsal; the fins are a little shorter, the eye a little larger, and the caudal peduncle usually slenderer. These differences, however, are far from constant, and are probably to be regarded as racial rather than specific or even subspecific. Should the Lake Superior race be found on further study to be worthy of specific or subspecific denomination, it must receive a new name, as *Cottus richardsonii* Agassiz is preoccupied.

Variation in Number of Anal Rays in Cottus bairdii

Locality	Anal rays			
	11	12	13	14
Sault Ste. Marie and Lizard Islands, Lake Superior	—	5	15	4
Cayuga Lake, New York	1	2	4	—

Cottus gracilis Heckel

Uranidea gracilis Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1968 (with synonymy).

Cottus gracilis Kendall, Bull. U. S. Fish Comm., 22, 1902 (1904), p. 362.

Cottus richardsonii Gill, Smiths. Misc. Coll., 52, 1908, p. 114 (in part).

A single specimen of this species is at hand from Michigan, a locality far west of any previously recorded for the species. It was collected in Little Manistee Creek, tributary to Lake Michigan, by Gen. John McNulta, in July, 1899. It agrees in essential respects with specimens taken at Ithaca and McLean, New York, from streams flowing into Cayuga Lake; from Worcester, New York, on the upper Susquehanna; and from Labrador.

Dorsal rays, VIII, 17; anal, 12; pelvics, each I, 3; first dorsal half as high as second, the two fins narrowly conjoined at base; pectoral reaching to above third anal ray. A prickly area in axil of pectoral fin, as in some specimens from western New York. Depth, 5.0; head, 3.0; eye, 6.2; upper jaw, 2.3; no palatine teeth. Upper parts marked with a rather obscure reticulated pattern, without definite bars. Fins dark, the first dorsal black with a narrow whitish margin. Length to caudal, 80 mm.

Cottus franklinii Agassiz

Cottus franklinii Agassiz, Lake Superior, 1850, p. 303; Girard, Proc. Am. Ass. Adv. Sci., 2, 1850, p. 411; Proc. Boston Soc. Nat. Hist., 3, 1850, p. 189; Smiths. Contr. Knowl., 3, 1851, p. 33, pl. 2, figs. 5, 6.

Uranidea franklinii Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1967.

Uranidea hoyi Putnam, in Nelson, Bull. Illinois Mus. Nat. Hist., 1, 1876, p. 41; Jordan and Evermann, *l.c.*, 1898, p. 1969.

Uranidea kumlieni Hoy, in Nelson, *l.c.*, 1876, p. 41; Jordan and Evermann, *l.c.*, 1898, p. 1967; Forbes and Richardson, Nat. Hist. Surv. Illinois, 3, 1908, p. 328.

Numerous specimens of this species were examined from Lake Superior (off Isle Royal, Lizard Islands, and Sault Ste. Marie), and one from Lake Michigan (off Ludington, Michigan). *Cottus franklinii* is known only from rather deep water in Lakes Superior and Michigan. The three nominal species, *franklinii, hoyi,* and *kumlieni,* the latter two described from Lake Michigan, seem to be inseparable, comprising a form but slightly differentiated from *Cottus gracilis.*

One specimen in the series at hand from Lake Superior has three soft pelvic rays on one side, four on the other.

Cottus ricei (Nelson)

Cottopsis ricei Nelson, Bull. Illinois Mus. Nat. Hist., 1, 1876, p. 40.

Uranidea ricei Jordan and Gilbert, Bull. U. S. Nat. Mus., 16, 1883, p. 953.

Cottus ricei Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1952; Forbes and Richardson, Nat. Hist. Surv. Illinois, 3, 1908, p. 327; Jordan and Thompson, Proc. U. S. Nat. Mus. 38, 1910, p. 78, fig. 3.

Uranidea pollicaris Jordan and Gilbert, Proc. U. S. Nat. Mus., 5, 1882, p. 222.

Cottus pollicaris Jordan and Evermann, Bull. U. S. Nat. Mus., 47, pt. 2, 1898, p. 1954.

This aberrant species heretofore has been known only from a few specimens taken in Lakes Michigan and Ontario. A series of five from Lakes Michigan, Huron and Superior, have been gathered together by the writer for comparison. A study of this lot has indicated that the presence or absence of prickles, as in several other cases in the genus, is merely an intraspecific variation. When present the prickles are either coarse or weak, and cover a varying proportion of the surface of the body below the lateral line. Just below the main, long, spirally curved preopercular spine there is a smaller downward directed spine, and below and before this one there are indications of about two smaller spines on the bridges of bone between the sensory cavities in the preopercle; the mandibular bones are similarly cavernous; the end of the maxillary is fleshy. Palatine teeth are absent, but simulated by rows of non-dentigerous papillæ, which were apparently mistaken for teeth by Nelson. Considering the foregoing facts there appear to be no grounds for the distinction of *Uranidea pollicaris* from *Cottus ricei*. The type descriptions of both nominal species conform in essential details with the specimens at hand. The more important characters of the series are tabulated below.

Table of Characters of Five Specimens of Cottus ricei

Lake	Michigan			Huron	Superior
Specimen (data given below)	1	2	3	4	5
Dorsal rays	VIII, 17	VII, 17	VII, 16	VII, 17	VIII, 18
Anal rays	13	14	13	13	13
Pectoral rays	17	16	16	16	16
Depth (approximate)	5.7	7.0	7.0	5.6	6.7
Head	3.35	3.2	3.3	3.25	3.0
Eye	5.6	4.6	4.7	5.5	4.4
Upper jaw	2.9	3.4	3.1	3.4	3.3
Length of preopercular spine from angle of ridge, into eye	1.0	1.0	1.0	0.8	1.0
Length to base of caudal	87	43	48	41	33

Prickles: Absent (1); weak, few below lateral line (2); absent (3); coarse, extending one-third distance from lateral line to anal base (4); coarse, investment complete (5).

Data for Specimens Similarly Numbered in the Above Table

1.—Mouth of Chicago River, Chicago, Illinois; collected by Emil W. Youngren, March 1, 1909; loaned by the Chicago Academy of Sciences.

2.—Lake Michigan, near Chicago, Illinois; deposited in the Field Museum through the city water system, from the intake about two miles out in the lake.

3.—Lake Michigan, off Ludington, Michigan; collected by Dr. R. J. Seymour; loaned by Mr. T. L. Hankinson.

4.—Near Port Huron, Michigan, at the southern end of Lake Huron; loaned by Mr. T. L. Hankinson.

5.—Lake Superior, from west end of Ambre Harbor, Michipicoten Island; collected by Dr. H. V. Ogden, September, 1901.

NUMBER 66 APRIL 19, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

CONTRIBUTIONS TO THE HERPETOLOGY OF IOWA, III

BY ALEXANDER G. RUTHVEN

The Museum of Zoology has been accumulating data upon the reptile and amphibian faunas of Iowa[1] through expeditions, loans and exchanges. The following notes are the result of field work by the writer in Palo Alto, Clay and Dickinson Counties, in the summer of 1918, and collections secured by Dr. T. C. Stephens, Morningside College, Sioux City, Iowa, and his students. The Museum is indebted to Dr. Stephens for the loan of material and for permission to retain specimens representing new locality records.

The specimens noted in the list of species were taken by the writer unless otherwise stated.

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[1] Previous papers on this subject are: Contributions to the Herpetology of Iowa, Proc. Iowa Acad. Sci., 1910, pp. 198-209; Contributions to the Herpetology of Iowa, II, *ibid.*, 1912, p. 207.

LIST OF SPECIES

Ambystoma tigrinum (Green).—Eastern Clay County, July 15, 1918; Sioux City, Woodbury County, T. C. Stephens.

Acris gryllus (LeConte).—Sioux City, Woodbury County, T. C. Stephens.

Pseudacris triseriata (Wied).—Gillett Grove, Clay County, July 29, 1918.

Hyla versicolor LeConte.—Center Lake region, Dickinson County, July 22, 1918; Lake Okoboji, Dickinson County, July, 1914, T. C. Stephens.

Rana pipiens Schreber.—Center Lake region, Dickinson County, July 22, 1918; Sioux City, Woodbury County, T. C. Stephens.

Plestiodon septentrionalis Baird.—Lake Okoboji, Dickinson County, July, 1914, T. C. Stephens.

Diadophis arnyi Kennicott.—Plymouth County, September, 1914, T. C. Stephens.

Heterodon nasicus Baird and Girard.—Blue Lake, Monona County, September, 1913, R. R. Vernon.

Coluber constrictor flaviventris (Say).—Sioux City, Woodbury County, May 10, 1903.

Elaphe vulpina (Baird and Girard).—Iowa Falls, Hardin County, August, 1913, W. J. Himmell; Sioux City, Woodbury County, June 4, 1913, T. C. Stephens.

Pituophis sayi (Schlegel).—Several specimens from Woodbury County collected by T. C. Stephens and the writer; Onawa, Monona County, September, 1913, R. R. Vernon; Ida County, May, 1913, W. J. Himmell.

Lampropeltis triangulum syspila (Cope).—Sioux City, Woodbury County, about 1914, T. C. Stephens. This specimen has been identified by Mr. Frank N. Blanchard.

Storeria occipito-maculata (Storer).—Lake Okoboji, Dickinson County, June 20, 1917, T. C. Stephens.

Thamnophis radix (Baird and Girard).—Several specimens from Woodbury County collected by T. C. Stephens and the writer; Lake Okoboji, Dickinson County, summer of 1912, T. C. Stephens.

Thamnophis sirtalis parietalis (Say).—Specimens from Woodbury County collected by T. C. Stephens and the writer.

NUMBER 67 APRIL 21, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

A NEW SPECIES OF TAPEWORM OF THE GENUS PROTEOCEPHALUS FROM THE PERCH AND THE ROCK BASS[1]

BY GEORGE R. LARUE

The collections on which this study is based were made by Professor A. S. Pearse of the University of Wisconsin in the course of investigations on the parasites of the fishes of Wisconsin lakes and by the writer while making similar investigations on the fish of Douglas Lake in northern Michigan. Professor Ward, of the University of Illinois, has also kindly permitted a study of the tapeworms of the perch in his very extensive collections. To Professors Pearse and Ward my thanks are due for the use of their material.

Proteocephalus pearsei, new species

Diagnosis: Characters of the genus. Size small; total length about 24 mm.; scolex of variable size, as large as 0.3 mm. broad by 0.13 mm. long. Neck relatively long, 1.3 to 3 mm. long. The four suckers small, measuring 0.051 to 0.087 mm. in diameter, with the average of ten about 0.071 mm. Fifth sucker functional, about 0.034 mm. in diameter. First proglottids broader than long, measuring about 0.32 to 0.48 mm. by 0.012 to 0.050 mm. Mature proglottids broader than long or nearly quadrate, 0.446 by 0.361 mm. to 0.896 by 0.245 mm. Ripe proglottids differing greatly in length and breadth, varying from 0.882 mm. broad by 0.782 mm. long in ovigerous proglottids to 0.446 mm. broad by 1.316 mm. in old proglottids nearly ready to be dehisced. Genital pore marginal, situated at 0.3 to 0.46 of the length of the proglottid from the anterior end. Testes numerous, about 60 to 90 in each proglottid, apparently arranged in one layer filling the space anterior to the ovarian lobes. Coils of vas deferens voluminous, extending to the mid-field of the proglottid. Cirrus-pouch short and relatively broad, 0.099 to 0.133 mm. long by 0.039 to 0.056 mm. broad, extending but little past the vitellaria. Cirrus and ductus ejaculatorius forming two or three coils within the cirrus-pouch. Ovarian lobes slender and long in much contracted proglottids, thickened, rounded or even bent back on themselves in some elongated proglottids. Vitelline follicles relatively coarse, closely packed together; vitellaria voluminous. Uterus with 7 to 9 lateral pouches on either side in less distended ovigerous proglottids, and as many as 15 or 16 in old elongate proglottids. Vagina anterior or slightly dorsal to cirrus-pouch. Sphincter vaginae small or lacking. Embryos of uterine eggs about 0.015 mm. in diameter.

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[1] Contribution from the Biological Station and the Department of Zoology, University of Michigan.

Habitat: Adult form in intestine of *Perca flavescens* (Mitch.) and *Ambloplites rupestris* (Rafinesque).

Distribution: Lakes Mendota and Monona, Wisconsin; Hubbard Lake, Alcona County, and Douglas Lake, Cheboygan County, Michigan.

Type Specimen: Cat. No. 161, Museum of Zoology, University of Michigan; taken from *Perca flavescens* (Mitchell), Lake Monona, Wisconsin; Sept. 22, 1917; A. S. Pearse, collector.

Description of Type Specimen: This tapeworm is short but robust. Its length (end-proglottid missing) is about 24 mm., its greatest width about 0.9 mm. From the appearance of the worm it seems doubtful if individuals ever attain a much greater length. The head, figures 1 and 2, is relatively broad and short, measuring 0.310 mm. broad at the posterior margin of the suckers while its length from the tip of the head to the line along which the breadth was measured is 0.130 mm. At a distance of 0.375 mm. from the tip occurs an expansion which measures 0.423 mm. in width. The head is thin dorso-ventrally. The rather long neck region is not well defined since it is relatively broad and passes almost imperceptibly into the segmented portion of the body. Traces of internal segmentation begin at 3.5 mm. from the tip of the head, making the neck a little more than 3 mm. long. It has no marked constrictions. The earliest proglottids distinguishable in the preparation measure 0.489 mm. wide by 0.050 mm. long. The twenty-fourth proglottid measures 0.733 mm. broad by 0.359 mm. long. This proglottid is rapidly approaching maturity, testes are nearly grown and the ovary is evident. The thirty-fourth proglottid, figure 4, is mature. It measures 0.896 mm. broad by 0.245 mm. long. The thirty-sixth proglottid has eggs in the uterine branches. With the production of eggs and their storage in the uterus the proportions of the proglottids gradually change from broader than long to longer than broad. The forty-ninth proglottid, figure 5, is 0.880 mm. wide by 0.782 mm. long while the fifty-ninth and last proglottid in the chain, figure 6, measures 0.733 mm. broad by 1.304 mm. long. The terminal or end proglottid has been lost. The segmentation is evident, the inter-proglottidal furrows being well marked.

The four suckers are muscular, deeply cupped, and 0.087 mm. in diameter with a cavity 0.056 to 0.06 mm. in diameter. An apical fifth sucker, figures 1 and 2, is present. It is considerably smaller and weaker than the four. It has a shallow cup, is muscular and has the appearance of being functional. Its diameter is 0.043 mm.

Genital organs, figures 4, 5, and 6, are arranged on the well known Proteocephalid plan. There is no genital papilla. The genital sinus is marginal, irregularly alternating, anterior to the middle, being situated in the anterior two-fifths of the proglottid. The cirrus-pouch is relatively short, reaching barely through the dense vitellaria. Five cirrus-pouches from ripe proglottids average 0.114 mm. long by 0.053 mm. broad. The longest of these measures 0.127 by 0.050 mm. and the shortest 0.099 by 0.050 mm. The maximum width of cirrus-pouch was 0.057 mm. The cirrus and ductus ejaculatorius form two or three coils within the cirrus-pouch. A completely protruded cirrus has not been seen but from the character of the nonextruded cirrus it is evident that it cannot be extended far. Coils of the vas deferens form a loose mass extending to the mid-field of the proglottid. There are about 60 to 64 testes which appear to lie in one layer filling the space anterior to the ovarian lobes and between the vitellaria. Testes measure about 0.035 by 0.027 mm. The largest ones measure about 0.040 by 0.037 mm. and the smaller 0.030 by 0.020 mm.

The vagina opens into the genital sinus anterior and somewhat dorsal to the cirrus-pouch. In its course to the mid-field of the proglottid it may lie anterior to the cirrus-pouch or it may cross the pouch dorsally. A sphincter vaginae seems to be lacking or if present is very weakly developed. It has not been seen in whole mounts of the worm. Ovarian lobes of mature and of most ripe proglottids are long and relatively slender. Vitelline glands are lateral, composed of many large follicles, closely packed together. In mature proglottids the vitellaria form thick masses while in more elongate proglottids they form narrower masses. Uterine pouches appear early. In old proglottids these reach to the vitellaria and come to occupy the greater proportion of the proglottid. There are about seven to twelve well-marked uterine pouches on either side of the mid-line in most ripe proglottids but in older proglottids, well distended with eggs, the pouches are more irregular and more numerous. Smaller pouches seem to have been crowded in between larger pouches, especially in the region of the median stem of the uterus, while the walls of the uterus in some of the larger proglottids seem to have given way. Ducts within the interovarial space could not be completely followed out in the preparation.

The six-hooked embryo of uterine eggs measures about 0.015 mm. in diameter. No determination of the egg membranes could be made.

Notes on Paratypes: A specimen collected by A. S. Pearse clearly belongs in this species. It differs from the type in having a narrower head (a contraction state) and a narrower neck. Its suckers are somewhat smaller, figure 3. These suckers measure 0.070, 0.077. and 0.076 mm. respectively, and their cavities 0.04, 0.04, and 0.047 mm. respectively. The fifth sucker measures 0.04 mm. in diameter and its opening 0.023 mm. The head at the level of the posterior edge of the suckers measures 0.228 mm. in width and the neck at its narrowest part just equals the width of the head. Since the neck is broken off at 2.84 mm. back of the head and there may be a small portion of it missing its full length cannot be measured. The six pieces on this slide appear to make up almost a complete worm. Their combined length is about 25 mm. In respects other than those mentioned this worm agrees with the type.

On the same slide is an immature worm with somewhat retracted head. Five suckers in fair agreement with the suckers of the type may be distinguished. This specimen is assigned to this species.

One small worm from perch, Lake Monona, Wisconsin, Pearse's No. 9/22/17-31, and another, No. 9/20/17-40, taken from Lake Mendota, Wisconsin, probably belong to this species. They are immature and the preparations are very poor making it impossible to secure all desirable diagnostic data.

Some headless fragments on another slide differ more widely from the type than do the preceding specimens. In these fragments the proglottids are narrower and longer, the ovarian lobes much shorter and more rounded, testes more numerous, intersegmental furrows less pronounced. Some of these fragments may be referred to this species but one fragment at least cannot.

In the material from *Perca flavescens* in Professor Ward's collection are a number of fragments which can be readily assigned to this species. Some of the larger specimens and complete worms have been studied in detail and their measurements are here given.

Specimen No. 12.147_2 of Ward's collection is immature. Its head is 0.134 mm. long and 0.178 mm. broad. Its four suckers measure 0.077 to 0.082 mm. in diameter and their cavities are from 0.046 to 0.056 mm. in diameter. The fifth sucker has a diameter of 0.034 mm. The neck, which is narrowest just back of the head, has a length of 1.26 mm. The first proglottids are 0.320 mm. broad by 0.012 mm. long.

A considerably more immature worm than the preceding is

No. 12.147_3 of Ward's collection. Five suckers are visible but the fifth is too indistinct to measure. One of the suckers measures 0.062 mm. and its cavity, 0.039 mm. in diameter. No mature or ripe proglottids are present.

Specimen 12.148_1 and 12.148_2 of Ward's collection are so nearly alike that data will be given only on No. 12.148_2 unless otherwise stated. The only sucker measured on specimen No. 12.148_2 is 0.065 mm. in diameter. On specimen No. 12.148_1 the suckers measure 0.051 to 0.062 mm., the neck, 1.41 mm. long by 0.260 mm. wide. Mature proglottids measure 0.446 by 0.498 mm. long; ripe proglottids, 0.461 by 0.595 mm. to 0.446 by 1.361 mm. long. A terminal proglottid is present. Its breadth is 0.446 and its length 1.265 mm. The position of the genital pore occurs from 0.3 to 0.46 of the length of the proglottid from the anterior end, with the average of ten falling at 0.35 of the proglottid length. The average length and breadth of ten cirrus-pouches is 0.112 and 0.047 mm. respectively. The minimum length and breadth in this lot of cirrus-pouches is 0.102 and 0.039 mm. respectively, while the maximum length and breadth in the lot are 0.021 and 0.056 mm. respectively.

The relations of the vagina to the cirrus-pouch are the same as in the type. In the region just anterior to the ovary the vagina is thrown into several coils. Counts of the number of uterine pouches in six old elongated proglottids were made. These counts are expressed in the form of fractions, the number of pouches on the porose side (side of the genital pore) being given as the numerator and the number of pouches on the aporose side as the denominator. The counts follow: 11/14, 11/11, 11/13, 10/14, 14/14, 15/16. It will be seen that there is a tendency for the greater number of pouches to occur on the aporose side. The ovarian lobes in quadrate proglottids are elongated. As the proglottids get older and more elongated the ovarian lobes are turned back and become rounded. In the last proglottid this process has gone on so far that the ovarian lobes touch in the rear. The six hooked embryos of uterine eggs measure 0.015 to 0.017 mm.

One complete worm taken by the writer from perch at Douglas Lake in northern Michigan differs very little from the type. It is strongly contracted. The suckers, which are almost withdrawn into the head, are about 0.066 mm. in diameter. The fifth sucker is just distinguishable. The neck is broad and about 1.30 mm. long. Two headless fragments mounted on the same slide clearly belong to the same species as the type.

A complete specimen, La Rue's No. 357_e, 13.4 mm. long and with a maximum width of 0.50 mm., was taken from a rock bass, *Ambloplites rupestris* (Raf.), at Douglas Lake, Michigan, by the writer in 1912. Studies of this worm mounted in toto show that it belongs in this species. Its measurements fall within the limits given in the diagnosis.

This species is much smaller than *P. cernuae, P. percae,* and *P. dubius* which infest the Percidae of Europe but resembles these in having a fifth sucker. In addition to differences in size of the worm there are many points of difference in the size of organs. This species is considerably smaller than *P. pinguis.* It is less fleshy and differs in many of its size relations. It somewhat resembles *P. exiguus* in size but is a slightly more robust worm than *P. exiguus.* This more robust appearance is particularly true of the head and neck. The genital pore of *P. pearsei* is differently located, the cirrus-pouch much smaller, testes more numerous, and the embryo smaller thin in *P. exiguus.* The form more closely resembles *P. pusillus* than any other described species, but its suckers are smaller, testes smaller, cirrus-pouch larger, and the relation of the vagina to the cirrus-pouch is somewhat different. This species is not to be confused with *P. ambloplitis* which also occurs in *Ambloplites rupestris* because of the great difference in size and in anatomical details.

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PLATE I

All outlines have been made with the aid of the camera lucida and details filled in at the same scale of magnification.

Abbreviations used: ci.p., cirrus-pouch; g.p., genital pore; tt., testes; ut.p., uterine pouch; v.d., vas deferens; vi., vitellaria.

Figs. 1 and 2. Head of type specimen seen from upper and lower surfaces respectively.

Fig. 3. Head of a smaller specimen found in Professor Pearse's material. Drawn to the same scale as figs. 1 and 2.

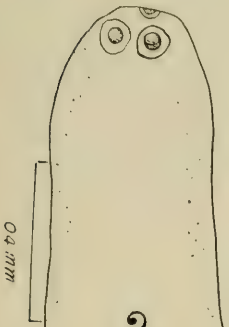
Fig. 4. Mature proglottid of type specimen.

Fig. 5. Ripe proglottid of type specimen.

Fig. 6. Last proglottid of type specimen.

Fig. 7. Mature proglottid from specimen 12.148_2 in Professor Ward's collection.

Fig. 8. Portion of proglottid showing the shape of ovarian lobes under certain conditions of contraction of the proglottid. Drawn to the same scale as fig. 7.



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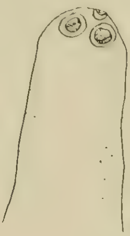

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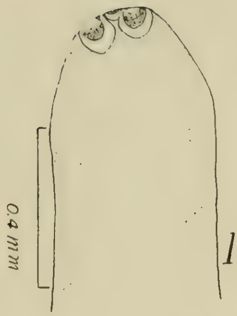

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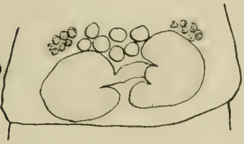

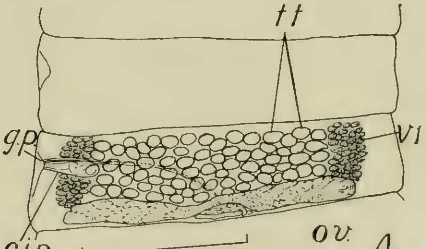

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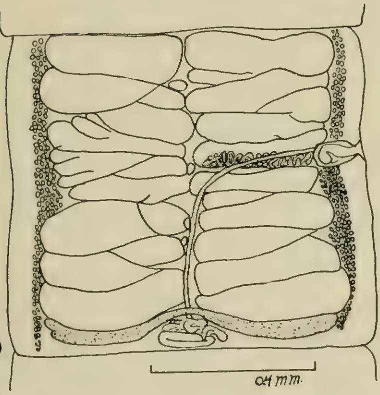

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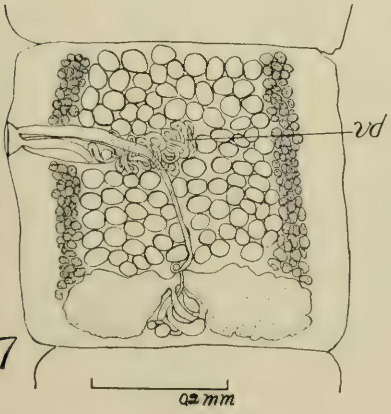

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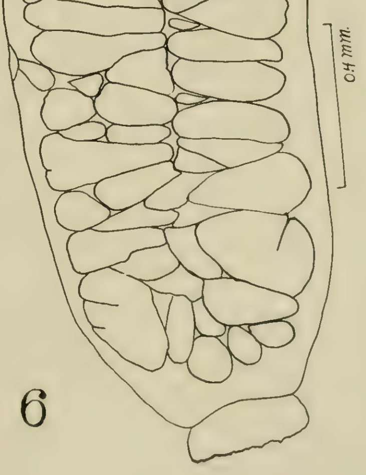

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NUMBER 68 APRIL 24, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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RESULTS OF THE UNIVERSITY OF MICHIGAN-WILLIAMSON EXPEDITION TO COLOMBIA, 1916-1917

IV. NOTES ON SPECIES OF THE GENUS HETERAGRION SELYS WITH DESCRIPTIONS OF NEW SPECIES (ODONATA)[1]

BY E. B. WILLIAMSON

In order to identify specimens of Heteragrion in my collection taken by B. J. Rainey, L. A. Williamson and myself in British Guiana, and by Jesse H. Williamson and myself in Colombia, it was necessary to study carefully the species hitherto described. The results of this study are embodied in the following paper.

Heteragrions are not common in collections and the total number of specimens is not large. Yet this material has shown the existence of a relatively large number of species, twenty-two having been named. The larger number of species were described from material in the collections of de Selys and

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[1] I, Occ. Papers Mus. of Zool., Univ. of Mich., No. 52, April 17, 1918. II, *ibid.*, No. 59, June 24, 1918. III, *ibid.*, No. 63, January 5, 1919.

Hagen. Unfortunately specimens of species of this genus are very fragile. Apparently many specimens have been lost from Hagen's collection, and information I have received indicates that there has been considerable damage and loss in the de Selys material. This is very unfortunate as certain species are unidentifiable from existing descriptions.

ACKNOWLEDGEMENTS.—Through Dr. Ris I have obtained drawings by Mons. Menger of the material at present available in the de Selys collection. Dr. Ris has also furnished me notes on material in his collection. I am especially indebted to Dr. Calvert for the loan of specimens, for several drawings, properly credited, and for suggestions. Other material of the greatest interest was borrowed for study from the Carnegie Museum, through Mr. Kahl; from the Museum of Comparative Zoology, through Mr. Banks; from Cornell University, through Professor Needham; and from the U. S. National Museum, through Mr. Currie. Mr. Kennedy kindly prepared many of the drawings, properly credited, and the wing photographs.

The Legion Podagrion of de Selys, as defined by him (1 and 2), has been briefly summarized by Calvert (5) as follows: M_3 separating from M_{1+2} nearer to the nodus than to the arculus. Stigma normal, i.e., consisting of but a single cell. Cu_2 present. Supplementary sectors present, at least between M_{1a} and M_2, except in Perilestes.

The genus Heteragrion (including Heteragrion and Oxystigma of this paper) of the Legion Podagrion may be briefly defined as follows: Antenodals two[2]; M_3 arising at or near the subnodus; R_s arising distad to the subnodus (rarely at the third postnodal, usually from the fifth to eighth); one cubito-anal cross-vein; supplementary sectors two, between M_{1a} and M_2; area posterior to Cu_2 one cell wide; stigma with the proximal side oblique, the proximo-posterior angle acute.

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[2] Herbert Campion, Proc. Acad. Nat. Sci. of Phila., May, 1913, p. 222: "A female of *Heteragrion chrysops* Hagen (*alienum*) from Vera Cruz, also in the Godman-Salvin Collection, has, in three of its wings, a supernumerary antenodal between the usual ones and limited to the costal space."

Heteragrions occur from approximately sea-level up to recorded altitudes of 3000 to 4000 feet, and they will doubtless be found at higher elevations. The genus is confined to tropical America. They are forest or shade insects, living along smaller streams from which they rarely wander for any distance, except species of group 4, Oxystigma, which are often found scattered through woodland. Rene Martin[3] reports that in the forests of Brazil birds of the genera Trogon and Galbula eat many dragonflies, among them Heteragrion. I doubt if many Heteragrions meet this fate. Their habits and surrounding are such that they suffer little if any danger from birds. Their predominant colors are various shades of brown to black, and various shades of yellow or, less frequently, red, blue and green. Larval stages are not known.

De Selys (1) divided Heteragrion into four groups, to the fourth one of which he proposed giving the name Oxystigma, as a "sous-genre". In 1886 (2) he divided Heteragrion into two sections, the first section containing the first three groups of his earlier paper, and the second section containing the fourth group, without further mention of Oxystigma. I have been unable to devise any better grouping than that of de Selys, and it is retained in this paper with additional characters employed in defining the groups. Another species of group 4, hitherto represented by a single species, has been discovered, and I believe it is well to place these two under a separate genus, Oxystigma, as originally proposed by de Selys.

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[3] Revue Francaise d'Ornithologie, No. 26, June, 1911, Sur les oiseaus qui se Nourrissend de Libellules, (3e note), p 98.

a¹. Quadrangle short; usually nearly two or more postquadrangular cells; the cubito-anal cross-vein much nearer the second than the first antenodal. *Heteragrion.*
  b¹. Inferior appendages of male rudimentary; teeth on genital valves of female several-rowed. Generally the hind margin of wing separating from the anal vein at a greater distance distad to the cubito-anal cross-vein than the arculus is distal to the cubito-anal cross-vein. Frons obtusely angled, similar in the sexes. Groups I and 2.
  b². Inferior appendages of male small, spine-like; teeth on genital valves of female one-rowed. Generally the hind margin of wing separating from the anal vein at a lesser distance distad to the cubito-anal cross-vein than the arculus is distal to the cubito-anal cross-vein. Frons acutely angled (males of some species) to right angled (females of some species and both sexes of some). Wings narrower (more or less) in the males than in the females. Group 3.
a². Quadrangle long; usually one or about one postquadrangular cell; the cubito-anal cross-vein about midway between the antenodals. Inferior appendages of male small, spine-like; teeth on genital valves of female several-rowed. The hind margin of wing separating from the anal vein at a greater distance distad to the cubito-anal cross-vein than the arculus is distal to the cubito-anal cross-vein. Frons low, rounded, similar in the sexes. Group 4. *Oxystigma.*

Of de Selys' group I only two species have been described. Only one of these, *flavovittatum,* is well known. The group was separated from group 2 by de Selys on the following characters: Head more robust; mouth more projecting; abdomen shorter; legs longer; third joint of antenna almost three times as long as the second joint; wings broader; hind margin of wing separating from the anal vein distad to the arculus; quadrangle of medium length. I have seen only an imperfect male and female of *flavovittatum.* The species is more robust, with slightly longer legs than the species of group 2 known to me. But these characters are not very definite, and the venational and antennal characters, as well as the sexual characters, are essentially those of group 2. I have measured the second and third antennal joints of all species known to me. In general the third joint is about twice the second, but in some females of groups 1 and 2 (*flavovittatum, aurantiacum, triangulare*) the third joint is longer, but in no case is it three times as long as the second: in group 4 (Oxystigma), the two joints are more nearly equal and are more robust than in the other three groups. Further evidence for the indistinctness of structural differences between groups 1 and 2 is found in the fact that the female, originally described as *ovatum,* group 1, (de Selys 1) was later (de Selys 2) referred to *ochraceum,* group 2. The species referred by de Selys to group 1 are, for convenience, discussed with the species in group 2. The type of the genus Heteragrion is *flavovittatum*; and of Oxystigma, *petiolatum.*

CHARACTERS OF GROUPS AND SPECIES.—The proportions of the second and third antennal joints have been mentioned above. *Face profiles and head coloration*: there are four fairly distinct types of face profiles (figures 63 to 66). The acute, up-turned frons is a male character confined to group 3. It is associated with a brilliant yellow or orange face, a velvety black posterior vertex (rarely the entire vertex) and a metallic yellow or orange area on either side of the median ocellus, adjoining the frons (except in those species where the black of the vertex reaches the frons). The females of these brilliant males are very different. In some of them the face may be largely black. The males of a few species of group 3 and the females of all that group have the frons about right angled. In groups 1 and 2 the frons is a little more rounded. It seems to be the same in the sexes of all the species. In coloration of head the male of *flavovittatum* approaches group 3, but the head patterns in both sexes of the species of group 2 are all very different from group 3. With few exceptions they are pale colored, variable, more or less indistinctly patterned, and very similar in the sexes. In Oxystigma (group 4), the frons is low and flattened. While in *cyanofrons,* of this genus, the head pattern of the male suggests group 3, the head pattern of the female is very similar to the male, thus differing from the condition found in group 3. *The hind lobe of the prothorax* offers a character which may be valuable in certain cases in determining species, and used carefully, it may be useful in associating the sexes. In all the material studied I have seen only one malformed prothorax. *The male abdominal appendages,* especially the superiors, are specifically distinct, but are often very similar. I have detected no variation within a species. The superior appendage by pressure or other causes is often rotated on its long axis; so figures may be more or less misleading, and, in the case of species having similar appendages, such figures cannot be relied on for the proper identification of specimens without reference to other characters. The *penes* have been studied by Mr. Kennedy but his results have not been published. He writes me that he has found this organ showing no specific characters in this genus. The *genital valves* are toothed along the ventral edge in all species. In group 3 the valve is relatively thin or narrow on the ventral edge, and the teeth are one-rowed. In all the others the ventral edge is broader, the teeth are several-rowed or paved, and the teeth are more flattened and scale-like than in the single-rowed forms. In all species the style is tipped with an acute translucent point which is formed by closely appressed hairs or bristles. The toothed edge of the genital valve is obviously the instrument by which an entrance is made for the insertion of the ovipositor. Frequently the interstices of the teeth are filled with minute debris, more or less concealing the teeth. This seems especially true of those with paved teeth. Among the females of group 3, where the teeth are single-rowed, the apical tooth is more or less distinctly larger, and there is a pretty uniform decrease in size basally. The number and spacing of the teeth vary in the different species of this group but are variable and of little use apparently in recognizing species. The single-rowed or paved condition is however recognizable at a glance. It is a most useful character, permitting for the first time the certain determination of the group relationships of any female specimen. The *ovipositor* consists of four parts, two anterior and two posterior, each anterior closely appressed to its corresponding posterior process. Each anterior process has its distal outer edge beaded or convoluted in a manner apparently characteristic of each species. The posterior process has along its distal outer border a series of oblique grooves or teeth, which extend basally farther than the beading or convolutions of the anterior process. When viewed from the ventral surface only the two anterior processes are seen, except that in certain cases the edge or apex of the posterior processes may be in view. This latter condition is especially true in the case of those species with narrow anterior processes. In those species with wide, flattened anterior processes, the apical portions of the posterior processes, bearing the grooves or teeth, lie well within the outer edges of the anterior processes and are not visible in a ventral view. The ovipositor is narrow in group 3, and widest in Oxystigma. I have studied it in only a limited number of species as it is usually concealed by the valves, and I did not wish to relax older and typical material loaned me for study. A thorough study of this organ must await the accumulation of more material. The apical beading of the anterior process I think has little or no function in the insertion of the ovipositor. In fact, it seems these irregularities would render the insertion more difficult. But in plant tissues, if it is in such situations that the eggs are placed, such a structure would serve to steady or maintain the ovipositor after it had been inserted. Likewise the grooves of the posterior processes cannot, I think, aid much in the insertion of the ovipositor. They lie generally within the lateral edges of the anterior processes and between these processes and the abdomen. Their function is probably concerned with the extrusion of the egg. *Venation*: several characters have been employed in describing groups or species. The distance between the arculus and the cubito-anal cross-vein, for example, can be measured with accuracy, for these parts lie at approximately right angles to the longitudinal veins bounding them. But the distance between the cubito-anal cross-vein and the point of departure of the anal vein from the posterior wing margin is an entirely different matter, as the anal vein and the posterior wing margin meet in a very acute angle. If the parts are viewed at such an angle as to superimpose the anal vein on the wing margin near their juncture point, the point of separation appears much more distal than is really the case. In studying this character I have held the plane of the wings at right angles to the line of vision, and with the long axis of the wings at right angles to the observer, studying them under a binocular microscope. With these simple precautions one can detect the real point of separation with a fair degree of accuracy. There is a great difference in the width of the wings between species and, in some cases, between the sexes of the same species. Wing narrowness in this genus is brought about solely by the narrowing of cells and no other change in the position of the larger veins takes place. Hence the character can only be used with difficulty, especially since all gradations between the extremes exist. The only way of expressing the character seems to be in some terms of measurement or in the proportion of width to length. Associated with wing narrowing is a reduction in the size of the stigma (compare figures 3 and 4). But this character, like narrowing, is difficult to express. The number of postquadrangular cells is an indefinite character, dependent as it is on the variable position of the origin of M_3 and an undifferentiated cross-vein. M_3 arises at or near the subnodus, but varies in the same species. The proximal cross-vein between M_3 and M_4 is the cross-vein which marks the distal extension of the postquadrangular cells. But this cross-vein has no specialized relation to the cross-veins posterior to it, which form the ends of the postquadrangular cells, and it may coincide with one of these or occupy any position between two of them. *Thoracic and abdominal color patterns* are varied and usually of specific value. The common ground color is some shade of orange-yellow; flesh, red, blue or bluish and green or greenish are rarer. With the exception of shining or metallic areas on the heads of some species, there are no brilliant or metallic colors. With but rare exceptions they are rather dull colored insects, and the females are practically all dull brown, obscurely patterned and inconspicuous. Generally in group 2 the dorsum of the thorax is pale with a middorsal black carina, which is universal in the genus, though rarely reduced to a mere thread. The mesepimeron is often largely dark, forming a conspicuous posthumeral dark stripe But in group 3, males of many species, which as tenerals have a similar pale thoracic pattern, have the dorsum darken with age till it may become entirely black. The color of the abdomen also undergoes some change with age, but it is slight and does not result in a virtual loss of color pattern, as is the case on the thorax. In males the third to fifth segments are usually the most definitely and intricately patterned. This pattern is of several distinct types. Each segment may be of a single color, without pattern, as in *erythrogastrum*; the segment may be apically dark or black as is *albifrons* or *chrysops*; the segment may be black at both apex and base with a pale mid-area, making a three-banded segment, as in *calendulum*; or the base may be pale, followed by a more or less distinct dark area, followed by the pale ground color, which is in turn followed by a distinct dark apex, thus making a four-banded segment. This last pattern is the most common. In this pattern the subbasal dark area varies in intensity with age. It is superimposed on the pale basal color and shades out apically. To a certain extent its development, by contrast, determines the presence or absence of a pale basal ring. The apical black is deeper and appears at an early age. The distinction between the two black areas is possible even in *majus*, where the excessive development of the subbasal dark area has resulted in segments 3-6 becoming chiefly black with pale basal rings.

GEOGRAPHICAL DISTRIBUTION OF GROUPS.—The two species of group 1 are recorded from Southern Brazil or Brazil. Of group 2, *macilentum* has been recorded from Venezuela, and *ictericum* and *melanurum* are now known from British Guiana; all the others are known between parallels 10° and 35° S., from southern and eastern Brazil, Paraguay, and Argentina. Of group 3, *icterops* has been recorded from Brazil (Santarem), Venezuela, Ecuador and Peru. It seems possible there have been some misidentifications. Four species have been recorded south of the equator in western South America, from Ecuador, Peru, and Bolivia. One species besides *icterops* is known from Brazil and one species occurs in British Guiana. The others occur to the west and north. Four species are known from the Magdalena River in Colombia; and one of these and the remaining species of the group occur in Central

America as far north as about 20° N. All the species known for Central America and for the Magdalena River (Colombia) belong in this group. Of group 4, the two species occur in British Guiana, and one of these has been recorded from as far south as Santarem, Brazil.

Key to Males of Groups 1 and 2[4]

a.¹ Dorsum of head, prothorax, thorax and first seven abdominal segments largely black, apical half of 8 and 9 and 10 entirely or largely yellow.
  b¹. A wide yellow humeral stripe; a dorsal black spot on abdominal segment 10 .... *flavovittatum.*
  b². Dorsum of thorax on each side with a yellow oval spot; abdominal segment 10 without a black spot .... *ovatum.*
a². Not as above.
  b¹. Segments 9 and 10 black above; head largely pale, markings obscure.
    c¹. Segment 8 largely yellow or yellowish above....... *ictericum.*
    c². Segment 8 black above .... *melanurum.*
  b². Segments 9 and 10 pale above (reddish or yellowish), similar to 8 or distal part of 8.
    c¹. A broad black posthumeral stripe; head above broadly and definitely patterned with black.
      d¹. Dorsum of thorax largely black; area below between the fork of the mid-dorsal carina black; mid-area of hind lobe of prothorax a definite round black spot. .*triangulare.*
      d². Dorsum of thorax, except area of the middorsal carina, pale, the area below between the fork pale; prothorax pale, the hind lobe without definite markings........... *beschkii.*
    c². No definite posthumeral stripe; head above largely pale, markings generally obscure and indefinite.
      d¹. Superior appendages in profile not swollen ventrally at base; apex of 7 and all of 8 pale............. *aurantiacum.*
      d². Superior appendages in profile swollen ventrally at base; apex of 7 and basal part of 8 black.............. *consors.*

Key to Females of Groups 1 and 2[5]

a¹. Prothorax and thorax dark above, a wide yellow antehumeral stripe, occupying about two-fifths the width of the mesepisternum and extending from the wings to the anterior edge of the prothorax. Antenna long, the second joint about .3 mm., the third joint nearly three times as long, the ratio about 1.5:4............*flavovittatum.*

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[4] For a discussion of *cinnamomeum, dorsale, macilentum, obsoletum* and *ochraceum*, known to me only from descriptions and not included in the key, see text.

[5] For a discussion of *macilentum, beschkii* and *amazonicum*, the females of which have been described but which are otherwise not known to me and are not included in the key, see text.

a². Thorax not sharply patterned as above; humeral or antehumeral stripe if present narrower and obscure, not definitely a part of the prothoracic pattern. Antenna shorter, the second joint about .2 mm., the third joint from two to nearly three times as long as the second.
- b¹. Cubito-anal cross-vein proximal to the arculus a distance equal to or less than the length of the latter. A distinct dark posthumeral stripe.
  - c¹. Basal dark area on dorsum of segment 9 divided in the median line by pale nearly or quite to the base of the segment...... ....*triangulare.*
  - c². Basal dark area on dorsum of segment 9 not divided by pale in the median line ....*ictericum.*
- b². Cubito-anal cross-vein proximal to the arculus a distance greater than the length of the latter. Dark color on dorsum of segment 9 not divided by pale in the median line.
  - c¹. No dark posthumeral stripe...................*aurantiacum.*
  - c². A distinct dark posthumeral stripe.
    - d¹. Posthumeral stripe brown, the same color as the dorsal thoracic brown stripes. Hind lobe of prothorax narrow, rounded and high—a female in Hagen's collection labelled *aurantiacum.*[6]
    - d². Posthumeral stripe black, darker than the thoracic dorsum. Hind lobe of prothorax similar to *aurantiacum,* broad, winged and with a median dark area..........*ochraceum.*

Key to Males of Group 3

a¹. Abdomen above predominantly pale, no segment as much as one-fourth definitely black; segments 1 and 2 without any definite black areas; 8-10 largely or entirely pale or obscure.
- b¹. Abdomen brilliant red, black inconspicuous or wanting.
  - c¹. Face black; abdomen without black..........*erythrogastrum.*
  - c². Face bright light yellow; abdomen with some segments narrowly apically black ....*albifrons.*
- b². Abdomen reddish yellow or flesh to almost red, segments 3-6 with distinct apical black areas; face yellow.
  - c¹. Abdomen 47-51.5 mm. long; usually three postquadrangular cells ....*tricellulare.*

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[6] By the form of the hind lobe of the prothorax certain known species are excluded, and the species may be *dorsale* (of which the female has not been described), *cinnamomeum* (unless this is a synonym of *aurantiacum,* as de Selys has stated; the female of *cinnamomeum* is not described), or *macilentum* (of which only the teneral female is described). See under *aurantiacum* in the text.

c^2. Smaller; usually two postquandragular cells.

d^1. Segment 7 colored like 8.................... *chrysops.*

d^2. Segment 7 darker than 8..................... *alienum.*

a^2. Abdominal patterns various but segments 1 and 2 with definite dark areas or at least some segments definitely largely or entirely black above.

b^1. Nasus and frons above black, face not bright yellow; the brightest and most conspicuously colored area is the middle lobe of the prothorax which is bright yellow........... *peregrinum.*

b^2. Face bright yellow or orange, frons above the same, and, with rare exceptions, on either side of and in front of the median ocellus, an area of the same color with metallic reflections.

c^1. Thoracic pale colors bluish or greenish: dorsum abdominal segments 8-10 black, on 8 the black narrowed from the base to a middorsal line at the apex; 3-7 narrowly but distinctly pale ringed at base.

d^1. Black on dorsum of head extended forward only to about the level of the front of the median ocellus; abdomen 37 mm. long .... *inca.*

d^2. Black on dorsum of head extended forward to between the antennae; abdomen 32 mm. long.......... *icterops*[7].

c^2. Thoracic pale colors yellow or yellowish; dorsum of abdominal segments 8-10 various, but dorsum of 8 not continuously dark in midline from base to apex.

d^1. Dorsum of abdominal segments 3-5 for two-thirds or more the length of each segment with a wide median longitudinal yellow stripe, bounded laterally by a dark line which thus separates the dorsal and ventral yellow; 8 with the dark area above confined to the basal half; 9 and 10 dark above; pale basal rings on 3-7 obscure or wanting... *flavidorsum.*[8]

d^2. Dorsum of 3-5 without a broad yellow stripe as above.

e^1. Size large, abdomen over 40 mm. in length.

f^1. Segments 3-6 dorsally and laterally largely black; 8-10 and the appendages to near the apex bright yellow .... *majus.*

f^2. Segments 3-6 dorsally and laterally narrowly pale at base and black at apex, the intermediate area yellowish or reddish, more or less obscured and dark on the basal half of each segment; 8 largely or entirely yellow or yellowish; 9 and 10 black above.

g^1. Legs blackish .... *æquatoriale.*

g^3. Legs largely yellowish........... *angustipenne.*[9]

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[7] Known to me only from descriptions; see text.

[8] Known to me only from description; see text.

[9] Known to me only from description; see text.

e². Size smaller, abdomen not exceeding 40 mm. in length.

f¹. Abdominal segments 4 and 5 without pale basal rings, the apical black on each segment anterior to them continuous with the basal black of 4 and 5, the intermediate color dull or yellowish red; segments 6 and 7 with this median pale area darkened so these segments are nearly or quite entirely black, unmarked; 8 reddish, indefinitely marked black, especially basally; 9 and 10 black above.......... *calendulum.*

f². Pale basal rings on segments 3 to 6 or 7, thus each segment four-banded (narrow pale basal ring followed by an extensive dark area, shading out into an extensive pale area, followed by an apical black ring) instead of three-banded (as segments 4 and 5 in *calendulum*).

g¹. Thorax dark above, in mature specimens entirely black; broad definite dark stripes on the mesepimeron and metepisternum; abdominal segments 3-6 with the large subapical pale area equal to or more extensive than the subbasal dark area which shades into it .... *mitratum.*

g². Thorax yellow above with a dark middorsal stripe and one on either side of the dorsum; mesepimeron with an extensive obscure area, and metepisternum with a very narrow obscure line; segments 3-6 with the dark subbasal area more extensive than the pale subapical area which follows it .... *simulatum.*

Key to Females of Group 3

a¹. Usually three postquadrangular cells in the front wing and sometimes (25%) in the hind wing; area enclosed by the fork below of the thoracic middorsal carina black; abdomen 40 mm. or more in length .... *tricellulare.*[10]

a². Two postquadrangular cells in front and hind wings.

b¹. A dark longitudinal dorsal stripe on either side of abdominal segment 2 dull and interrupted or wanting, not black and continuous and wider apically; sides above of 3 little if any darkened subbasally, hence a narrow middorsal pale line continuous with a pale basal ring wanting or obscure.

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[10] I have before me a single female lacking the entire abdomen, so I do not try to place this species in the key more satisfactorily. It will be immediately recognized by the characters given. Some other species are nearly as large.

- c^1. Area enclosed by the fork below of the thoracic middorsal carina entirely or partly pale........................*albifrons.*
- c^2. Area enclosed by the fork below of the thoracic middorsal carina entirely black.
  - d^1. No trace of a longitudinal median dorsal pale stripe on the abdomen ....*erythrogastrum.*
  - d^2. A very narrow thread-like longitudinal median dorsal pale stripe on abdominal segments 3 to 5 or 6........*alienum.*

b^2. A black longitudinal dorsal stripe on either side of abdominal segment 2, enclosing a median pale stripe which does not reach the apex; 3 with a distinct pale basal ring joining a pale longitudinal median stripe.

- c^1. Abdominal segment 9 with a black basal spot on either side, enclosing a distinct pale median bar which extends from the base to more than half the length of the segment; appendages black ....*mitratum.*
- c^2. Abdominal segment 9 pale or obscured but without definite pattern; appendages more or less pale, especially at the base.
  - d^1. Size large, abdomen over 35 mm. in length; anal vein separating from the posterior border near or at the cubito-anal cross-vein ....*majus.*
  - d^2. Size small, abdomen less than 35 mm. in length; anal vein separating from the posterior border at the level of or distad to the arculus........................*peregrinum.*

Key to Species of Group 4, Oxystigma

a^1. Male.—Thorax black or dull above, lateral pale markings obscure; face largely blue. Male and female.—Quadrangle short, not reaching the level of the nodus; R_s and M_3 widely separated at their termintion, R_s turned toward M_2..........................*cyanofrons.*

a^2. Male.—Thorax with dorsal and humeral pale stripes or lines, dorsum and sides bright, not obscure, and color pattern definite; face black. Male and female.—Quadrangle long, reaching the level of the nodus; R_s normal at its termination..........................*petiolatum.*

DISCUSSION OF SPECIES

1. *Heteragrion flavovittatum* Selys

Figures 12, 13, 119, 120, 133

This species has been recorded from Minas Geraes, Brazil. There are a male and a teneral female in the Hagen collection, both imperfect. Each has a small label "Hagen", a small blue locality label, "MG" (Minas Geraes), and a large green species label; in addition the male has a black-bordered species label, and a label by Kennedy "penis drawn." The male in the de Selys collection, figured by Menger (figures 119 and 120), bears identical blue and green labels. There is also in the Hagen collection a female with a small printed label "Hagen", a large white label on which is written "Lagoa Santa Lund", and another similar but larger label on which is written "*Argya signata* nob." The specimen is teneral and in poor condition, but I believe it is certainly *flavovittatum*.

The hind lobe of the prothorax of the male specimen is not fit to figure, but it is apparently similar to that of the female, with the black more extensive.

A wing of this species has been figured by Needham (A Geneologic Study of Dragon-fly Wing Venation, Proc. U. S. Nat. Mus., Vol. XXVI, Plate LIII, figure 6), in which Rs arises at the third postnodal, at about one-fifth the distance from nodus to stigma, instead of at about one-third the distance as stated by de Selys in his definition of Heteragrion.

The arculus is distal to the cubito-anal cross-vein .7 to .8 mm.; and the anal vein separates from the posterior border .7 to 1.0 or 1.1 mm. distad to the cubito-anal cross-vein. The face profiles in both sexes are about as in figure 65.

2. *Heteragrion ovatum* Selys

A much larger species than *flavovittatum* (abdomen male 44, hind wing 31, as compared with abdomen 32 to 35, hind wing 27 to 28 in the male of *flavovittatum*), and with a relatively longer abdomen. Only the male is known, the teneral female provisionally referred to this species by de Selys in 1862, being referred to *ochraceum* in 1886. The male is known only from a single male from Brazil in the Museum of St.

Petersburg. It was seen and described (in manuscript) by de Selys about fifteen years before the Synopsis of 1862 was published. Apparently it was never seen again by de Selys. Evidently its resemblance to *flavovittatum,* as shown by de Selys' notes on the St. Petersburg specimen, was his reason for referring it to his group 1. In the note following his description (de Selys 1), where he compares it with *dorsale, flavovittatum* is certainly meant.

From the above notes, it is evident that the species is poorly known, its relationships uncertain, and its indicated habitat indefinite.

3. **Heteragrion ictericum,** new species

Figures 8, 14, 15, 54, 65, 74, 75, 134, 135

Abdomen, male 31 to 36 mm., average 34; female 28.5 to 30: hind wing, male 22 to 23; female 24.

Male.—Rear of head, genae, face and vertex, yellow, lighter in front, passing gradually into darker posteriorly to become orange on the vertex; labrum more or less obscured, angle of rhinarium and nasus usually darker, sometimes black; ocelli with their opposed sides narrowly bordered with black; on each side, between the lateral ocellus and the eye is a more or less defined black bar, widened at either end and not reaching the ocellus; occipital crest black with more or less obscure shadings at the ends; all markings on vertex ill defined and variable. Antenna brown, the first two segments paler to yellow. Profile as figured, figure 65.

Front lobe of prothorax black in front, a median yellow area; middle lobe yellow, a dusky area on either side; hind lobe yellow, a dusky median area and a black spot on the extreme lateral margin. Propleuron yellow.

Thorax with a narrow middorsal black stripe, continuous above with the antealar sinus and covering the area included in the fork of the carina below; on either side of this median black stripe a more or less distinct yellow stripe of about equal width; a wider and clearer antehumeral stripe; between these two pale stripes the mesepisternum is yellow, darkened with brown shading to a very variable degree, so the dorsum may appear largely yellow, or, at the other extreme, almost black; in every case the dark area is most developed above and along its outer border; the antehumeral yellow stripe runs straight across the mesinfraepisternum; above it becomes posthumeral and occupies the upper end of the mesepimeron, which otherwise is largely black; the dark area is carried across the mesinfraepisternum which latter below, and the lower and posterior portion of the mesepimeron are yellow; metepisternum yellow with a black or brown stripe, starting near the upper end and passing through the stigma to the coxa; metepimeron paler yellow than the two anterior sclerites, sometimes with a small dusky area above. Beneath and coxae yellow.

Abdomen above largely dark, 4-7 and 9-10 the darkest; 1 pale dull yellow, darker in the median line and apically; 2 brown, a long rounded median basal yellow spot, darker basally on either side of this spot; 3 brown, a yellow basal ring and a black apical one of about the same width, a very narrow pale middorsal line continuous with the basal ring, varying from about one-third the length of the segment to, but not dividing, the apical black ring; an obscure but evident subapical pale area; 4-7 similar, black replacing the brown and the middorsal longitudinal pale line absent; 8 dull orange yellow, obscure at the base and narrowly black ringed apically; 9 and 10 black. Seen from the side 1 is largely dull yellow, an inferior posterior marginal black spot; lower half of 2 yellow, the inferior border black edged; 3-8 with the dorsal colors and pattern carried onto the sides; 9 dark obscure orange at base below; 10 with sides largely dark obscure orange. Superior appendages black; rudimentary inferiors dull yellow.

Legs light brown, femora each with two more or less distinct darker areas.

Wings clear or with a very faint tinge of brownish; stigma black or very dark brown, oblique, covering two to two and one-half cells; of 30 front wings, 20 have two postquadrangular cells, 2 have two plus, 4 have three minus and 4 have three; of 30 hind wings, 18 have two minus and 12 have two; postnodals of front wing are 16 to 20, of hind wing 15 or 16; in the front wing the arculus is distal to the cubito-anal cross-vein about .4 mm., in the hind wing about .3 mm.; in both front and hind wings the anal vein separates from the posterior border about .4 to .5 mm. distad to the cubito-anal cross-vein.

Female.—Head similar to that of male, but much duller, rhinarium and nasus more extensively dark. Profile as in the male.

Prothorax light brown, front lobe black along the front border, wider on either side; middle and posterior lobes patterned as in the male, largely dusky. Propleuron light, or light yellowish, brown.

Thoracic pattern as in the male, but the pale colors are light brown, the two pale stripes on the mesepisternum only more or less yellow tinged; between these two stripes the mesepisternum is always brown, black below at the outer border, thus darker than the darkest males in the present material.

Abdominal segments 1-7 similar to the male, slightly duller, brown rather than black except at each apex; 8-10 brown, 10 lighter, 9 with a broad dull yellow oblique ring which is subapical in the middorsal line and runs downward and forward ending on the extreme anterio-ventral border; sides of 8 and

10 dull yellowish below. Appendages dull yellow at base, brown at apex.

Legs similar to those of male.

Wings clear to tinged yellowish brown; stigma light brown, oblique, covering two to nearly three cells; 6 front wings all have two postquadrangular cells; of 6 hind wings, 4 have two postquadrangular cells, and 2 have two minus; postnodals of front wing 17 or 18, of hind wing 13 to 15; the relations of the cubito-anal cross-vein to the arculus and to the separation of the anal vein from the posterior border are as in the male.

Material Studied: Wismar, Tumatumari and Potaro Landing, all in British Guiana, January 31 to February 10, 1912, a total of fifteen males and three females, collection E. B. W.: Tamanoir, Mana River, French Guiana, May and June, 1917, S. M. Klages collector, collection Carnegie Museum, a total of twenty-four males and thirteen females, both tenerals and adults in each month. Type male, Wismar, January 31, 1912; allotype female, Tumatumari, February 9, 1912.

In the Proceedings of the National Museum, Vol. 48, pp. 626 and 627, I have described a small stream between Wismar and Christianburg where we collected. *Heteragrion ictericum* was taken along this stream associated with *Epipleoneura lamina* and *fuscaenca*.

4. **Heteragrion melanurum**, new species

Figures 9, 16, 76, 77, 136

Abdomen, male 32 to 34 mm.: hind wing, male 21 to 22.

Male.—Rear of head and genae yellow; labrum yellow to dark brown, yellow along the anterior border, rhinarium and nasus yellow, the latter sometimes darker to deep orange, darker medianly and in front; frons orange or reddish brown;

vertex orange brown or dull red, obscurely marked with black to a varying degree; ocelli with their opposed sides very narrowly black; a short transverse line through the median ocellus, with a more or less anterior fork on each side or with a transverse line near the frons; on either side a black bar between the antenna and eye; a thread of black, not always descernible, from behind each lateral ocellus to the eye; occipital crest black. Antenna obscure yellow, first joint brown or black, second joint darker at apex, third joint with basal half pale, and the apical half darker, with a submedian black or brown ring. Profile similar to figure 65.

Prothorax dull yellow, front lobe bordered with black in front; middle lobe brown in the middle and with an indefinite brown area on either side; hind lobe black, posterior margin on either side, but not reaching the extreme lateral margin, yellow. Propleuron bright yellow.

Thorax very similar to that of *ictericum*; the large dark area on the mesepisternum, between the pale line adjoining the middorsal carina and the pale antehumeral line, is better developed than in *ictericum,* covering the entire area between the two pale stripes, reddish brown along its inner border, but developing into very dark brown or black along the entire outer border; on the other hand, the dark on the mesepimeron, as compared with *ictericum,* is slightly shortened above and is interrupted below a short distance above the mesinfraepisternum; the brown on the metepisternum is variable, sometimes interrupted; the small superior spot on the metepimeron is always present.

The description of abdominal segments 1-7 and 9 and 10 of *ictericum* will apply equally well to *melanurum,* except that possibly in the latter the pale colors are lighter and brighter yellow, and 2 lacks the median basal pale spot; but 8, which is largely dull orange yellow in *ictericum,* is black or dark brown above, paler below in *melanurum,* with a narrow obscure pale basal ring which widens at the lower lateral margin. Superior appendages brown, paler basally; rudimentary inferiors yellow.

Legs yellow, femora each with two large brown or black areas, dividing the femur into five subequal areas; a trace of darker at base and apex.

Wings clear or with a very slight brownish tinge; stigma brown or black, covering from scarcely two to two and one-half cells; two postquadrangular cells in all wings but one hind wing where there are two minus; postnodals of front wing are 15 to 19, of hind wing 14 to 16; the arculus is distal to the cubito-anal cross-vein about .3 mm. or slightly less in both front and hind wings; the anal vein separates from the posterior border from less than .4 to .5 mm. distad to the cubito-anal cross-vein.

Female.—Not known.

Material Studied: Wismar and Rockstone, British Guiana, January 30 to February 1, 1912, four males, collection E. B. W. Type male, Rockstone, February 1, 1912.

The darker abdomen and the slenderer appendages will separate this species from its close ally, *ictericum.*

5. *Heteragrion triangulare* Selys

Figures 17, 18, 112, 137, 138

The type is a female from southern Brazil in the Museum of Vienna (1). In 1886 de Selys described an incomplete male and female from Rio Janeiro in McLachlan's collection and referred them to *triangulare,* with the remark that it was uncertain that the specimens were the same as the unique female at Vienna. Calvert (4), in identifying specimens in the Carnegie Museum from Chapada, Brazil, as *triangulare,* clearly implied that he did not regard this material as conspecific with the McLachlan specimens. I have studied the specimens from Chapada, and I agree with Calvert. I have no idea what the McLachlan specimens are, but they are certainly nearer *aurantiacum* than the species determined by Calvert as *triangulare.* The species was credited to Hagen by de Selys (1) but later (2) was credited to de Selys. The same shift occurs in the case of *macilentum.*

The profile of the head in both cases is similar to figure 65. The arculus is distal to the cubito-anal cross-vein .3 to .4 mm., and the anal vein separates from the posterior border .2 to .3 mm. distad to the cubito-anal cross-vein in the front wings and .4 to .5 mm. in the hind wings.

6. *Heteragrion macilentum* Selys

This species seems distinct by the male having a very dark head (apparently darker than *triangulare*) and by lacking a distinct broad black posthumeral stripe. It was described (de Selys 1) from specimens from Porto Cabello, Venezuela, and from Brazil in the Museum of Vienna and the de Selys and Hagen collections. In 1886 (de Selys 2), under the name misspelled *macitentum,* the Venezuela record is repeated, but a question mark, without explanation, follows Brazil. Only the very teneral female has been described (de Selys 1) and its identity with the male was later questioned (de Selys 2). The description of the female contains nothing definite. The same shift in name of author occurs here as I have noted under *triangulare.* The species is no longer represented in the Hagen collection and I have not seen any specimens. In view of its apparent relationships its occurrence in Venezuela, far to the north of the range of its allies, is remarkable.

7. *Heteragrion dorsale* Selys

This species is known from a single male from Nova Friburgo, Brazil, in de Selys' collection. In the key to males of group 1 and 2 it will run out to *triangulare* and *beschkii;* it has head markings similar to *triangulare,* and dorsum of thorax similar to *beschkii,* but the prothorax is almost all black.

8. *Heteragrion ochraceum* Hagen

Figure 19

This species was described (de Selys 1) from both sexes from Nova Friburgo in the collections of Burmeister, Hagen and de Selys. At the present time only a single female is in Hagen's collection. The labels on this specimen are interesting: there is a small written label "Heyer"; a large written label *"Argya cinnamomea* female Hagen"; another written label *"H. ochraceum* female"; a written black-bordered label *"H. ochraceum* Hag."; and a small printed label "Hagen". De Selys (1) has Heyer's name following *Heteragrion cinnamomeum,* but he states that the female of *cinnamomeum* is unknown and later (2) he makes *cinnamomeum* a synonym of *aurantiacum.* For further discussion of this point see text under *cinnamomeum.*

The female character, "un tubercle renflé derrierè chaque oeil sur l'occiput, que est jaune", emphasized by de Selys (or Hagen), I do not understand. There is nothing peculiar in the head of the female specimen in the Hagen collection labelled *ochraceum* by Hagen. Otherwise I believe this specimen is the one on which the description (de Selys 1) was based. The hind lobe of the prothorax is not in condition to figure; it has wide wings, similar to figure 142, but with the edges convex. There is a rounded dark central area.

The male of *ochraceum* is described as near *beschkii*; the basal third of the labrum, middle lobe of prothorax, a central spot on the posterior lobe, the dorsal thoracic carina and the area below between the fork, black. Apparently the first and last characters above enumerated separate it from *beschkii,* and the last character from *dorsale*; the pale thoracic dorsum separates it from *triangulare.* It is also described as having the "base of the abdomen" black with a median yellow line. In this it is apparently different from all other species in group 2 but *obsoletum.* See text under *cinnamomeum.*

The profile of the female in the M. C. Z. is like figure 65. The arculus is distal to the cubito-anal cross-vein about .6 mm., and the anal vein separates from the posterior border .7 to 1.1 mm. distad to the cubito-anal cross-vein.

9. *Heteragrion cinnamomeum* Selys

Figures 123, 124

In the original description (de Selys 1) *cinnamomeum* was doubtfully placed as a race of *aurantiacum.* The material from Bahia consisted only of males, according to the text, and was in the de Selys and Hagen collections. It is not plain from the text whether de Selys or Hagen was the author. At any rate there is some confusion, since, if any male specimens were in the Hagen collection, they have been lost, the species being represented there by a single female which I have discussed at some length under *ochraceum.* In 1886 de Selys (2) apparently regarded *cinnamomeum* as a synonym of *aurantiacum,* but in the text he indicated a difference by stating "C'est probablement à la race *cinnamomeum* qu'il faut rapporter une femelle etc."

In de Selys' collection is a male, figured by Menger (figures 123 and 124, which, among other labels, bears three labels *"cinnamomeum"* all in de Selys' handwriting. This is clearly specifically distinct from *aurantiacum* in the same collection and also figured by Menger (figures 121 and 122). May not this specimen labelled by de Selys *cinnamomeum* be *ochraceum*? De Selys knew the latter species directly only from a single teneral female. As evidenced by the female in Hagen's collection we know that Hagen, who possibly knew both sexes of both *cinnamomeum* and *ochraceum*, regarded the former as a synonym of the latter.

10. *Heteragrion beschkii* Hagen

Figures 20, 82, 83, 139

A female, doubtfully referred to this species, has been described (de Selys 2) but the description is inadequate. The species is represented by a single male in the Hagen collection. This has two written pin labels *"H. beschkii"*, one of which is black-bordered, and another written label, "Brasil-New Freiburg, Beschke—*Argya aurantiaca*." The small printed pin label "Hagen" and written label "penis drawn" by Kennedy are also attached. This specimen, which is in good condition, is the type.

The profile of the male is like figure 65. The arculus is distal to the cubito-anal cross-vein .5 to .7 mm., and the anal vein separates from the posterior border .7 to .8 mm. distad to the cubito-anal cross-vein.

11. *Heteragrion aurantiacum* Selys

Figures 21, 22, 78, 79, 111, 121, 122, 141, 142, 143, 144

This species was recorded from Bahia, Brazil and from Buenos Ayres by de Selys (1 and 2), the specimens from Brazil in his collection, the specimens from Argentina in

Hagen's collection. The latter material consists now of a single female, and there is no way of determining whether or not other specimens formerly existed. The figure of *aurantiacum* by Menger is of the type or one of the type specimens, collected by Clausen. Calvert (4) relying on de Selys' description alone, identified material from Rio de Janeiro, Brazil, and Sapucay, Paraguay, as *aurantiacum.* The Menger figure serves to confirm the correctness of his determination. Later Ris (7) identified specimens from Argentina as *aurantiacum.*

The female in the Hagen collection bears the following written labels: "Von Heyer-Buenos Ayres", "*H. aurantiacum* female", a black-bordered label "*H. aurantiacum* Sel.", and the small printed label "Hagen." I have discussed this specimen briefly in the key to females of groups 1 and 2, and in footnote 6. (See also figures 23 and 140.) It certainly is not the same species as the females identified by Calvert (4) as *aurantiacum,* and, if I am right in believing that Calvert's identification is correct, this specimen must be some other species than *aurantiacum.* If I am correct in thinking *cinnamomeum* is a synonym of *ochraceum,* and if the female in the Hagen collection labelled *ochraceum* is correctly named, then the female, labelled *aurantiacum,* cannot be *ochraceum.*

In pronouncing the Hagen female labelled *aurantiacum* as specifically distinct from the material so determined by Calvert, I have relied largely on the form of the hind lobe of the prothorax. It is improbable but possible that *aurantiacum* in its range varies in this character to the extent shown by figures 140 and 142. That the hind lobe does vary to a considerable length extent however, or that two species are confused under one name is shown by a comparison of the material from Brazil and from Paraguay (Calvert 4), all of which is before me. The specimens from Brazil differ from the specimens from Paraguay in the hind lobe of the prothorax, especially in the female, where the great lateral wings of the Brazilian specimens are not duplicated elsewhere in the series (see figures 142 and 144). Otherwise I am unable to detect any clear differences. The males from Paraguay are larger than those from Brazil in width of head, size of thorax, and length of wings and abdomen, as shown by the following measurements:

Width of head: Paraguay, 5.5; Brazil, 5.
Length of abdomen: Paraguay, 40; Brazil, 38.
Length of hind wings: Paraguay, 26; Brazil, 25.

But these differences are no more than might be expected between individuals of a species from a single locality. The thoracic dorsum of the Paraguay males is brighter and more definitely marked than in the others but all specimens are in poor coloration.

In addition to the material studied by Calvert (4), I have had for study a single male from the state of Sao Paulo, Brazil, Coll. Cornell University, lot 298, sub 362. This specimen is like the Brazilian specimens.

In both sexes the profile of the head is like figure 65. The arculus is distal .5 or .6 mm. to the cubito-anal cross-vein, and the anal vein separates from the posterior border .6 or .7 mm. distad to the cubito-anal cross-vein in the front wing and .9 to 1.1 mm. in the hind wing.

Before the correct status of the several species of group 2, living between 20° and 40° south latitude can be determined, more and better material must be collected.

12. *Heteragrion amazonicum* Selys

Described (de Selys 2) as possibly distinct from *cinnamomeum,* which he regarded as a race of *aurantiacum.* In his description he speaks of it as larger than other species of the group (abdomen 34, hind wing 27) but his description of *aurantiacum* (1) gives the same measurements for that species except that the hind wing is 26. There is nothing distinctive in the description and the indefinite locality, "pris par M. Bates sur l'Amazone", will make the identification of this species impossible in the future if the type female is not preserved.

13. *Heteragrion consors* Hagen

Figures 24, 80, 81, 145

The Hagen collection contains a male in a good state of preservation. It bears the printed labels "Hagen" and "Winthem"; and the following written labels: two black-bordered labels, one *"H. consors* Hagen", the other "Bahia", another *"H. consors",* and "penis drawn" by Kennedy. This specimen is the type. The female has not been described.

The profile is like figure 65. The arculus is distal .6 to .8 mm. to the cubito-anal cross-vein, and the anal vein separates from the posterior border 1.0 to 1.3 mm. distad to the cubito-anal cross-vein.

14. *Heteragrion obsoletum* Selys

Described (2) from a single male from Cochambu, southern Brazil. The species seems to have no relatives in the group in which de Selys placed it, though he compared it with *ochraceum,* the male of which, however, he knew only from Hagen's description. It is a small species (abdomen 31, hind wing 25, while other species of the group have the abdomen 37 to 41, and the hind wing from 23 to 30), and seems very distinct by its blue and greenish pale markings and its color pattern.

15. *Heteragrion erythrogastrum* Selys

Figures 1, 30, 31, 58, 64, 71, 84, 85, 125, 126, 146, 147

Calvert (3) and Ris (8) have pointed out that the processes of the male inferior appendages are small and variable. In some specimens they are invisible in a profile view but may be detected in an oblique posterior view. De Selys' reference of the species to his group 2, rather than 3 where it really belongs, was due doubtless to his material having the processes concealed or minute. By venational characters, however, he should have referred it to group 3 as the arculus is distal to the cubito-anal cross-vein from .3 to .5 mm., while the anal vein separates from the posterior border usually near the cubito-anal cross-vein, distad .1 to .2 mm.

Calvert (3) and Ris (8) have briefly described the teneral male. Such specimens, in their abdominal pattern, suggest the adults of allied species (*chrysops,* etc.). The thoracic pattern of such teneral males is similar to that of the adult female. As the male matures the pale stripes, adjoining the middorsal black, blacken and disappear at least in some cases before the pale humerals are lost.

Colombian specimens are larger with a tendency to fewer postnodals than specimens from Central America, as shown by the following data:

Abdomen male, Colombia 35 to 42, average 37, Canal Zone 34 to 35.

Abdomen female, Colombia 30 to 33, average 31; Canal Zone 28.

Hind wing male, Colombia 24 to 26; Canal Zone 22 to 23.

Hind wing female, Colombia 25 to 26; Canal Zone 22.5.

Postnodals front wing male, Colombia 16 to 18; Canal Zone 16 to 18.

Postnodals hind wing male, Colombia 14 to 16; Canal Zone 14 to 15.

Postnodals front wing female, Colombia 15 to 16; Canal Zone 17 to 18.

Postnodals hind wing female, Colombia 13 to 15; Canal Zone 14 to 15.

Thus the difference between the lengths of the abdomen of the largest and smallest males is 8 mm., and of females 5 mm. No other species shows such variation in size. The profile is similar in both sexes.

Under *mitatrum* some habits of *erythrogastrum* are noted. We found it commonly along all the streams at Cristalina excepting the Rio Diez-y-ses where we did not see it during the single day we collected there. It is a relatively conspicuous insect, the blood red abdomen contrasting strongly with the green and browns of its environment, as it rests with half-spread wings on twig tips. The wings vary from clear to brown or dingy tinged. We observed it about Cristalina from about 8 or 9 a.m. till nearly 5 p.m. when the ravines were dark and gloomy. A male, taken at Cristalina, has the abdomen turned once on its long axis at the sixth segment, like a corkscrew. We took a number of Mecistogasters similarly malformed. Evidently during emergence from the exuvia, before the apical abdominal segments are released, the soft teneral, agitated by some cause and attached to the exuvia only by the apical segments, is twisted or turned, producing the corkscrew malformation of the adult.

Material Studied: This species is well represented in several collections; I have examined 194 males and 35 females. To the localities recorded by de Selys (2), Calvert (3), and Ris (8), the following may be added: Costa Rica: Bonnefil Farm, Rio Surubres, 700 feet; Rio Siquiares; Turrucares, 2000 feet; Rio Guapiles; Philadelphia South Farm; Alajuela, 3100 feet; Quebrada de Salas, Atenas Station; East of La Emilia; small stream north of Turrucares; April, June and August to December, inclusive, 1909 and 1910, a teneral in December, a pair in August and October, remarks "creek in woods", "brook in shade", "more open part of quebrada"; a total of 23 males and 10 females all collected by and in the collection of P. P. Calvert: Canal Zone, Rio Sardanilla, December 5, 1916, 27 males and 3 females, Chas. T. Tribolet and E. B. Williamson, collectors, coll. E. B. W.: Colombia, Cristalina, Department of Antioquia, February 12 to 20, 1917, 135 males and 8 females, J. H. and E. B. Williamson, collectors, coll. E. B. W.

16. *Heteragrion albifrons* Ris

Figures 2, 32, 33, 61, 72, 86, 87, 148, 149

This species has recently been described by Ris (8) from a single male from Reventazon, Costa Rica. The species is represented in Dr. Calvert's Costa Rican material by the following specimens: Peralta, August 9, 1909, in low woods, one male; Turrialba, 2300 feet, July 26, 1909, 10 males, 3 females; Guapiles, forest, June 2, 1909, pair; Juan Vinas, 2500 feet, May 3, 1910, 1 female; Reventazon Valley, Juan Vinas, July 23, 1909, 2 males, 1 female; Reventazon Valley, below Juan Vinas, 2500 feet, June 28, 1909, 2 males; Reventazon road, Juan Vinas, 2500 feet, stream in forest, April 28, 1910, 1 male. This is the Heteragrion referred to by Dr. Calvert (6) on pages 228 and 251, and probably page 192. The male from Cachí, Costa Rica (Calvert 3), referred to *erythrogastrum,* and the female from the same locality, questionably referred to *chrysops* (Calvert 3), are also very probably this species.

This is one of the handsomest species of the genus. It seems to me the name is not very appropriate as the male, to which alone the specific name is applicable, has the face bright light gold. It is, however, paler than in any other species. The profile in the male is like figure 63, and in the female like figure 64. As might be expected the female is very similar to the female of *erythrogastrum*; *albifrons* is a slenderer, more delicate insect, with the middorsal thoracic black stripe narrower.

17. *Heteragrion tricellulare* Calvert

Figures 34, 35, 36, 107, 150, 151

This large species is known only from Mexico and Guatemala. I have seen only three imperfect specimens, two males and a female, studied by Dr. Calvert (3) now in the U. S. Museum. The profiles are like those of *albifrons*. The arculus is about .5 mm. distal to the cubito-anal cross-vein, and the anal vein separates from the posterior margin at the cubito-anal cross-vein or distad as far as .2 mm. The following material has not hitherto been recorded: Purulha, Guatemala, July 11, one male, collected by Wm. Schaus, in collection of P. P. Calvert. "Purulha is correct spelling, not Purula as Champion spells it."—Letter from Wm. Schaus to Dr. Calvert.

18. **Heteragrion alienum**, new species

Figures 5, 37, 38, 39, 57, 68, 88, 89, 105, 152, 153

This is the species described by Dr. Calvert (3) and referred to by all authors, excepting de Selys and Hagen, as *chrysops*. I have not seen the female of the latter species, but a male in the Hagen collection, the type or one of the types of *chrysops*, shows the distinctness of the two. The hind lobe of the prothorax, as figured, seems specifically distinct, and the tooth on the superior appendages is triangular and more basal in *chrysops* than in *alienum*, where it is more slender and acute and more apical. The profiles are like those of *albifrons*. The arculus is .3 to .6 mm. distal to the cubito-anal cross-vein, and the anal vein separates from the posterior border .1 to .4 mm. distad to the cubito-anal cross-vein.

Chrysops is said (de Selys 2) to have the abdomen reddish orange or even carmine; the Hagen specimen has it redder than in any specimens of *alienum* seen by me. The color character used in the key for separating the males of *alienum* and *chrysops* may not prove constant. *Alienum* is known from Mexico, Guatemala, Honduras and Panama.

The following material has not hitherto been recorded: Puerto Barrios, Guatemala, June 23, 1909, E. B. Williamson, collector, four males and two females, one of the males the type and one of the females the allotype, in coll. E. B. W.: Cayuga, Guatemala, March 21 (forest streams), April 5 (forest stream), May 3 (forest), June 4 (forest), six males, all collected by Wm. Schaus, in collection of P. P. Calvert. "Cayuga is 23.4 miles from Barrios; the elevation of station is 107 feet and the forest ridge is about 400 feet higher. The hills in question are on the south side and are covered with dense tropical forest (no pines at all)."—Letter from Wm. Schaus to Dr. Calvert.

19. *Heteragrion chrysops* Hagen

Figures 40, 90, 127, 128, 154

This species is known only from Porto Cabello, Venezuela. The type, or one of the type males, is in the Hagen collection. The face of this specimen is broken and the profile cannot be determined. The arculus is .4 mm. distal to the cubito-anal cross-vein, and the anal vein separates from the posterior border from .1 to .4 mm. distad to the cubito-anal cross-vein. The female is not known. See remarks under *alienum*.

20. *Heteragrion flavidorsum* Calvert

Figures 41, 108, 155

Described (Calvert 4) from a single male from Coroico, Bolivia, May 19, 1899, collected by W. J. Gerhard, coll. Acad. Nat. Sci. Phila. In the pattern of abdominal coloration it is apparently different from all other species in the genus.

21. *Heteragrion majus* Selys

Figures 42, 43, 62, 67, 91, 92, 106, 129, 130, 156, 157

This fine large species was described from males from Chiriqui, Panama. It has also been recorded from Peru (Ris 8). The male studied by Calvert (3) is in the Hagen collection. I have also seen two males and one female from Cachí, Costa Rica, collected in February, March and July, 1910, by Schaus and Barnes, in the Calvert collection, and so identified by Calvert. The profiles are like those of *albifrons*. The arculus is .4 to .5 mm. distal to the cubito-anal cross-vein, and the anal vein separates from the posterior border from .3 to .5 mm. distad to the cubito-anal cross-vein.

22. *Heteragrion aequatoriale* Selys

Figures 44, 45, 93, 113, 131, 132, 160, 161

This species was described (Selys 2) from males from Bogota, Colombia, and from the Rio Bobonaza, Ecuador. In describing the teneral male the abdomen is stated to be 32 mm., this doubtless should be 42 mm. The species has also been recorded from Peru by Calvert (4) and Ris (8). The specimens studied by Calvert are a male and female in the U. S. Museum. Both are in poor condition and the female is so teneral as to be unidentifiable, except by size and association with the male. Menger's drawings (figures 131 and 132) indicate that the specimen in the de Selys collection has the tooth on the superior appendages placed more basally than in the case of the Peru male in the U. S. Museum. Otherwise, as pointed out by Calvert (4), the Peru male agrees with de Selys' description, though it is slightly larger, abdomen over 48 and the hind wing 29 mm. In both sexes the profile is like figure 64. The arculus is .5 to .6 mm. distal to the cubito-anal cross-vein, and the anal vein separates from the posterior border at or as far as .2 mm. distad to the cubito-anal cross-vein.

23. *Heteragrion angustipenne* Selys

Figures 29, 109, 110, 158

Described by de Selys (2) as a possible race of *aequatoriale*. The three last segments were lost from the single male. A very much smaller specimen from Peru (abdomen 42, hind wing 24.5, as compared with abdomen 48, hind wing 29, of de Selys' specimen) has been identified as this species by Calvert (4). The differences in size are probably not incompatible with specific identity. De Selys briefly described the female as resembling *aequatoriale* and *icterops*, but he did not describe *aequatoriale*, except to give abdomen and wing measurements, and the description of *icterops* is brief and contains nothing distinctive.

24. **Heteragrion calendulum**, new species

Figures 46, 94, 159

Abdomen, male 36 mm.; hind wing, male 23.5.

Male.—Rear of head dull orange, darker above; face, frons above and vertex in front bright orange; not so reddish as in *mitratum*; rear of vertex black, the line between black and orange about the level of the lateral ocelli, with a bar forward to the rear edge of the median ocellus; metallic areas, with the granular or hammered-brass like surface, as described for *mitratum,* but yellow, more gold like, and larger in *calendulum,* the median division between them less evident, and, on either side, but not touching the eye, is a rounded area ot the same color and metallic surface. Antenna with the first two joints and all of the third but the apex yellow, remainder brown. Profile similar to that of *mitratum.*

Prothorax similar to that of *mitratum,* with the pale color inclining to orange rather than yellow, the dusky area on either side of the middle lobe represented by only a tinge of darker, but the lower border narrowly and more or less completely black.

Thorax above, the mesepimera and the mesinfraepisterna largely rich reddish brown; a black middorsal stripe, on either side of which is a scarcely discernible pale stripe about half as wide; the lower outer area of each mesepisternum is yellow or yellowish and there is a faint paling along the humeral suture (this last pale area being the remnant of the pale humeral stripe of *mitratum*) ; the area on the thoracic dorsum between the dorsal and humeral paler lines is darker above, shading out below; probably it never becomes entirely black as in *mitratum;* mesinfraepisternum black below in front; metepisternum and metepimeron brownish yellow, with an indefinite reddish brown area, which shades out below, on each sclerite. Beneath and coxae yellow, coxae darker in front.

Abdominal segment 1 yellow, a large dusky median spot above and the lower posterior border black; remainder of abdomen flesh red and black; 2 largely pale, a small basal dusky area on either side above, enclosing between them an incipient longitudinal median stripe, a more indefinite apical median dusky area, and the extreme lower lateral border black edged; 3 with an indistinct yellow basal ring, followed by red, the apical fifth or slightly less black; 4 and 5 black at base, followed by a larger area of pale, with the apex black to the same extent as 3; 6 and 7, and 9 and 10 black, some traces or suggestions of red in the mid-area of 6 and 7; 8 largely reddish brown, indefinitely darker at base and at apex, the dark color more extensive in the middorsal area, palest on the sides below; 9 and 10 seen from the side are also dull yellowish below; dorsal and lateral color patterns of 3-7 similar. Superior appendages black; inferiors brownish yellow, the spine dark brown or black.

Legs dark brown or black; first femora largely on the inner (lower) side, second femora at the base and on the inner side distally, and third femora entirely, except the apex, light brown.

Wings similar in shape to those of *mitratum*; saffron tinged to the arculus; distal to the arculus with scattered indefinite light brown tinged areas; stigma black, covering from slightly less to slightly more than two cells; two postquadranglar cells in all wings; postnodals of front wing are 18, of hind wing 16; in both wings the arculus is distal to the cubito-anal cross-vein about .3 mm., and the anal vein separates from the posterior border at the cubito-anal cross-vein or very slightly distad in the hind wings.

The following brief color notes were made from the recently killed male: duller than *mitratum,* eyes above black; thorax reddish brown, more reddish than *mitratum*; humeral and first lateral suture yellow; abdomen dull reddish and black.

Type: Described from a single male, taken along the Quebrada Sabaleticus, near Cristalina, Department of Antioquia, Colombia, February 17, 1917, collected by J. H. and E. B. Williamson, collection of E. B. W.

In the itinerary of our trip to Colombia[11] I have described (page 17) the small tributary of the Quebrada Sabaleticus where we found Mesagrion. We collected along the Quebrada Sabaleticus only a short distance above this small tributary. On the afternoon of February 17 I heard black howlers up the quebrada as I came out of the small tributary, so followed up stream as much to see the monkeys as to collect dragonflies. After finding the monkeys and seeing one make a splendid leap, I was returning to the tributary about 3:30 p.m. when I saw a Heteragrion resting on the twig tip of a small dead bush which had lodged on a bit of sand and debris in mid-stream. It occurred to me that the insect was generally duller than the common *mitratum*. Moreover we were capturing every *mitratum* that came readily to hand to make sure that we were not overlooking some similar species. So the specimen resting on the dead twig was netted, and its specific distinctness was recognized before it was dropped into the cyanide bottle. A brief search in the neighborhood resulted in the capture of specimens of *mitratum* only. Two days later J. W. made a special trip up the Sabaleticus to look for the females of Mesagrion and for this new Heteragrion but he failed to find either. The brilliant metallic areas on the vertex have suggested the specific name.

25. **Heteragrion mitratum**, new species

Figures 3, 4, 50, 51, 56, 63, 69, 95, 162, 163

Abdomen, male 36 to 40 mm.; female 29 to 30.5: hind wing, male 21.5 to 24; female 23 to 24.5.

Male.—Rear of head light yellow; genae, face and anterior part of vertex brilliant reddish orange; rear part of vertex black; the transverse line between orange and black at approximately the level of the posterior edge of the median ocellus, which is nearly surrounded by black; an anterior spur of black on either side toward the antenna, rarely wanting; the area posterior to the frons and between the antennae brilliantly metallic with a fine granular surface; the area is divided into two by a narrow non-metallic bar from the median ocellus to the frons; rarely the black is reduced in front by withdrawal along the anterior line between the median ocellus and the lateral ocelli and on the outer side of each lateral ocellus. Antenna with the first two joints and the base or more of the third yellow, the remainder brown. Profile as figured, figure 63.

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[11] A Collecting Trip to Colombia, South America, Mis. Publ. No. 3, Museum of Zoology, Univ. of Mich.

Front lobe of prothorax black, posterior lateral margins yellow; the black posteriorly V-shaped, the apex reaching the black of the posterior lobe; remainder of middle lobe yellow, with a more or less developed brown or black area on each side; posterior lobe black, a more or less distinct posterior pale area on either side. Propleuron yellow, black edged below in front.

Thorax rich black above, sides yellow, a narrow orange line on either side of the middorsal carina, disappearing below and joined above with a wider humeral stripe which ends on the mesinfraepisternum but does not cross it; the humeral stripe is posthumeral above and antehumeral below; mesepimeron with a wide black bar, parallel to the yellow humeral stripe and hence occupying the posterior part of the sclerite above and the anterior part below; near its upper end this black area is more or less distinctly joined with the dorsal black, thus dividing the humeral pale stripe which is joined above and behind with the pale area of the metathorax; below the mesepimeral black extends across the mesinfraepisternum, the posterior lower portion of which is yellow, and joins the black area of the mesepisternum; metepisternum with a black bar, wider above, not reaching the wing base, tapering and ending below at or near the stigma; metepimeron broadly livid along its anterior suture; some small black spots and lines at wing bases. In darker, and presumably older individuals, the dorsal and humeral pale stripes darken and, in extreme cases, entirely disappear; the dorsal stripes go first, and they may be scarcely discernible, except at the extreme upper end, in individuals in which the humeral stripes remain bright yellow. Beneath and coxae yellow, the latter more or less darkened in front.

Abdomen above reddish orange and black; 1 yellow with a median black or brown spot, more or less divided in the median line; 2 black or brown, paler apically with a longitudinal median yellow stripe; 3-6 with a narrow basal pale ring, followed by a brown or black area shading out into pale, followed by a narrow apical black ring; 3 with a median longitudinal pale line, continuous with the basal ring and disappearing posteriorly in the subapical pale area; 7-9 reddish brown, 7 the darkest and dullest; 10 black without definite pattern. Seen from the side, 1 yellow, lower posterior border black; 2 black or dark brown above, shading out below into brown, wider basally, which shades out leaving about the lower half or more yellow, the extreme lower border and apex black; 3-6 similar to dorsal view, the subbasal brown on 3 paler than on 4-6, not reaching the lower border; on 4-6 the pale basal ring is lengthened or expanded below thus shortening the subbasal dark area; this dark area suffers a greater reduction posteriorly by the lengthening of the subapical pale area which is shortest on the middorsum and longest in the midventrum, but 3 or 4-6 are as definitely four-banded in ventral as in dorsal view; 7-10 as in dorsal view, except that 10 is like the preceding segments, the black being confined to the dorsum. Superior appendages black; inferiors dull yellow or orange.

Legs brown or black; the femora paler, yellowish, or brownish, the hind femora the palest, sometimes entirely pale except apex.

Wings bright saffron tinged at base to the first or second antenodal, remainder of wing usually hyaline, rarely tinged light brown or dingy yellow; stigma black, covering scarcely one and one-half to two cells; two or two plus postquadrangular cells in the front wing, two minus to two plus in the hind wing; postnodals of front wing 16 to 18, of hind wing 14 to 16; in both front and hind wings the arculus is distal to the cubito-anal cross-vein about .4 mm., and the anal vein separates from the posterior border about .2 mm. or less distad to cubito-anal cross-vein.

A number of tenerals were taken which show the changes in coloration with maturity. In the most teneral the face is light lemon yellow, darker on the vertex, the black on vertex reduced, and paling to brown over considerable areas; the pale markings of thorax and abdominal segments 1 and 2 are almost white, cream colored, and there is a dark indefinite area above on the metepimeron. This dark area is found on all the tenerals; all of them have the thorax equally pale, and the pale color of the abodmen varies from light lemon yellow to lemon, but the color pattern is preserved in all. In all the tenerals the wings are entirely hyaline, no saffron tinging at base. In a teneral, slightly more mature than the youngest one, the face is yellow and the vertex in front is orange, the black of the vertex not reduced in area but with some obscure or pale areas. In a still more mature teneral the face, as well as frons above and vertex in front, is orange, though the pale thoracic markings remain cream colored or rather livid, with scarcely a trace of yellow; the black of the vertex is not reduced in area or density.

Female.—Pale markings of head, prothorax and the thorax, and to a lesser extent of abdomen, pale dingy cream color; genae brighter, lemon yellow; labrum, nasus, frons at either extremity, first joint of antenna in front, a large area against the eye opposite each antenna, and more or less of the vertex, black; frons brown or dark green, more or less distinctly pale in front; labrum with a large basal median pale spot and sometimes the general color brown instead of black; vertex black posterior to the frons and in front of the median ocellus over approximately the area which is metallic orange in the male; the region of the ocelli and the rear of the vertex is black, sometimes with obscure brown or pale areas especially along the eyes, leaving a large and variably shaped pale area between the region of the ocelli and the eye. Antenna with second joint brown or black, distal joints brown. Profile similar to figure 64.

Prothorax patterned as in the male, except that the lateral pale areas on the hind lobe are more extensive, isolating the median black as a large more or less rounded spot. Propleuron pale, tinged lemon yellow.

Thoracic pattern similar to that of the male, the light and dark pattern never lost above by darkening as it often is in the males; the humeral pale stripe crosses the mesinfraepisternum, and the black stripe on the mesepimeron fades out indefinitely below but continues as a variable brown or dusky area on the mesinfraepisternum; a dusky area above on the mesepimeron is sometimes present. Beneath white, coxae tinged lemon yellow.

Abdomen seen from above largely brown or black, the pale markings except on 1 more or less yellow; 1 dingy white, a median dusky area; 2 dark brown or black with a narrow median longitudinal pale stripe of varying length; 3-7 each with a more or less distinct pale basal ring, followed by dark brown which at the apex shades into black, and with a thread-like median longitudinal pale line which starts in the pale basal ring and ends at or near the apex of the segment; the above pattern dullest, sometimes obscured, on 7; 8 largely black or dark brown, darkest at base and apex; 9 with a large black basal spot on either side, one-half to two-thirds the length of the segment, separated in the median line by a broad longitudinal bar of dull yellow which, at its distal end, meets a broad subapical oblique transverse pale bar which terminates on either side on the lower basal margin of the segment; 10 narrowly black at base and in the median line, remainder of dorsum pale, or this obscured and darkened so the dorsum, at the other extreme, may be largely dark brown or black. Seen from the side, 1 white, lower posterior margin black; 2 black above, lower half or more dull lemon yellow; 3-7 similar to 2 but the pale area does not reach the apex, which is black, and there is an indefinite longitudinal inferior bar or streak of dark brown which begins near the base of each segment and extends posteriorly to or beyond the middle of each segment; 8 obscurely pale below; 9 dark brown with a broad oblique bar from near the apex above to the basal inferior margin, the lower margin largely pale; 10 dull yellow below shading out into brown or black above. Appendages black.

Legs similar to those of the male, but paler and duller, the colors light and dark brown.

Wings slightly tinged with brownish; stigma brown, covering slightly less to slightly more than two cells; slightly less than two to slightly more than two postquadrangular cells in both front and hind wings; postnodals of front wing 16 to 19, of hind wing 15 to 17; in both front and hind wings the arculus is distal to the cubito-anal cross-vein .3 to .4 mm., and the anal vein separates from the posterior border .2 to .3 mm. distad to the cubito-anal cross-vein, the greater distance being more usual in the hind wings.

A teneral female has the head much paler, brown replacing black, except the spots opposite the antennae next the eye, and the brown areas less extensive than the black areas of the mature females; the thorax is slightly paler, and the abdomen much paler, the subbasal brown areas reduced both on the dorsum and sides, in density of color only on the dorsum and in both density and extent on the sides; 9 and 10 are largely pale, with the dark areas indicated but dim.

Material Studied: Maraquita, Department of Tolima, and Cristalina, Department of Antioquia, Colombia, February 3 to 20, 1917, 17 males and 1 female at Maraquita, and 184 males and 14 females at Cristalina, collected by J. H. and E. B. Williamson. Type male and allotype female, Cristalina, February 18, 1917, in coll. E. B. W.

This species was the only Heteragrion observed at Maraquita where it was found along the upper San Juan and more rarely along the lower San Juan. We found it along every stream we visited about Cristalina but it was very rare along the Quebrada Cristalina. It was most abundant along the Quebrada La Camelia, so far as our experience went, a little more than one-half our material in both sexes being taken during the single day we spent on that creek.

At Maraquita we made the following note: "Rests on twig tips and occasionally on leaf edges with the body horizontal or slightly hanging (not hanging like *alienum*), wings half-spread; always in shade." And at Cristalina: "Males of this species and *erythrogastrum* in the afternoon come out from the jungle to open places along the creek, and from some advantageous perch catch their prey like fly-catchers, returning again and again to the same resting place. Males of the same species frequently fight, dancing rapidly and pugnaciously, heads on, before each other. Females of both species oviposit unattended by the males." As the males of *mitratum* fight each other, the only part of the insect visible to the observer may be the brilliant metallic areas on the vertex, which, even in the scanty light of late afternoon, flash like minute golden flames against the green of the jungle, turning and darting here and there, and disappearing to flash again. The same little head-light, more often than anything else, betrays the resting insect to the collector. Though I noted that the female oviposits unattended by the male, I unfortunately failed to record the place of oviposition, and I have no recollection of the matter. The black posterior vertex of the male with its two anterior prongs or angles makes the specific name appropriate.

One female specimen has the head of a bee firmly attached to the tarsus of the right front leg. Through the kindness of Mr. Currie, this head was identified by Mr. J. C. Crawford as a Trigona. I have previously recorded[12] a similar occurrence in *Archaeogomphus hamatus*.

A male of *mitratum* was sent to Dr. Ris who wrote: "Similar to what I have considered *H. aequatoriale* but specifically distinct without question; unkown to me."

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[12] II, A New Species of Agriogomphus (Odonata), Occ. Papers, Mus. of Zool., Univ. of Mich., No. 59, p. 16.

Heteragrion species.—In Dr. Calvert's material, collected by himself, is a very teneral male taken at La Emilia, Costa Rica, November 16, 1909. The species is distinct from anything known to me though it is doubtless closely related to *mitratum*. The specimen is however so teneral that the form of the appendages cannot be determined. Its most distinctive character is the coloration of the head, in which it resembles *angustipenne* (figure 29), the vertex being black to the frons, and to the same level on either side between the antenna and the eye, with a small indention of pale color posterior to each antenna. The metathoric dark stripes are better developed than in teneral specimens of *mitratum;* the abdominal markings and wings are apparently identical in the two, though the stigma may be slightly shorter in *mitratum*. While it is certainly an addition to the known Central American fauna, more material is necessary for its description.

26. **Heteragrion simulatum**, new species

Figures 48, 49, 70, 97, 98, 164, 165

Abdomen, male 34 mm.; female 29: hind wing, male 21.5; female 22.5.

Male.—Rear of head, genae, face, frons and vertex to level of the median ocellus, bright yellow; remainder of vertex black; small obscure brown areas on the genae and a small brown spot on each side between the antenna and eye. First two joints of antenna and basal half of third bright yellow, remainder brown. Profile like figure 64.

Prothorax bright yellow, front lobe with a median black spot, and on either side, an indefinite dusky area; middle lobe with the merest trace of dusky on either side; hind lobe with a large rounded median black spot which encroaches on the middle lobe but does not quite reach the posterior border; extreme lateral margins of the hind lobe dusky. Propleuron bright yellow.

Thorax above similar to *ictericum,* but brighter, clearer yellow, the two pale stripes, the one adjoining the middorsal black and the antehumeral, equally bright; the dark area is darker above, the inner and outer borders equally dark (thus differing from *ictericum*), and shading out below, especially on the outer border, leaving the outer half or more of the sclerite below yellow; doubtless when more specimens are known this dark area will be found to be variable in extent; sides bright yellow; mesepimeron dusky, especially along the humeral suture and below, indefinite and obscure but carried across the mesinfraepisternum as a brown line; metepisternum with a narrow stippled line from near the top to the stigma; a small dusky stippled area above on the metepimeron. Beneath and coxae yellow.

Seen from above abdominal segment 1 is largely yellow, dusky at the base in the median line; 2 brown above with a longitudinal median yellow line, which does not reach the extreme base or apex; 3-6 brown above, apex broadly black, a narrow yellow basal ring from which a narrow longitudinal middorsal yellow line runs posteriorly to, but not across, the black apex; this longitudinal yellow line widest on the anterior segments; the brown, adjoining the basal yellow ring, grows progressively darker posteriorly, so on 6 the remaining brown, adjoining the apical black, appears as a relatively light colored area; 7 brown, a basal yellow ring, the extreme apex very narrowly black; 8 similar but paler, the subbasal brown shading out at once posteriorly into dull orange; 9 similar to 8 but darker, a narrow median longitudinal yellow line from the base for about three-fourths the length of the segment, the narrow apical black of 8 wanting;

10, like 9, dark orange or reddish brown, a median longitudinal black line. Seen from the side 1 is entirely yellow except a narrow posterio-inferior border of black; 2 is largely yellow, with the extreme lower border narrowly dark or black; 3 broadly yellow below, except at the apex where the black encircles the segment; 4-6 similar, but the subbasal brown spreads down to the lower margin, thus dividing the pale into a basal and a subapical area; 7 same as from above; 8-10 similar to 7, but 9 darker, and 10 brighter and paler, especially beneath. Superior appendages largely dark brown; inferiors yellow, shading apically into brown.

Legs dull yellow, obscurely blotched and lined with brown, especially the femora, the first femora the darkest.

Wings clear; stigma dark brown, slightly oblique, covering one and one-half to scarcely two cells; two postquadrangular cells in front wing, two minus to two in hind wing; 15 postnodals in front wing, 12 or 13 in hind wing; in the front wing the arculus is distal to the cubito-anal cross-vein about .5 mm., in the hind wing about .4 mm.; in front and hind wings the anal vein separates from the posterior border from .2 to .3 mm. distad to the cubito-anal cross-vein.

Female.—A very teneral and poorly colored female is referred to this species. Head light brown, obscurely and indefinitely marked with darker. Prothorax very light brown, almost white, patterned as in the male, with obscure brown more extensive. Thorax patterned about as the female of *ictericum,* due to teneral condition light and darker brown in color; a well defined streak above on the metepimeron. Abdomen similar to the male, very light brown or cream replacing the yellow, and brown replacing the richer darker brown of the male; 1-7 similar to the male, less darkening of the subbasal dark color, and dark brown replacing the apical black; 8-10 uniform brown; appendages brown. Legs dull cream and brown, patterned as in the male. Wings similar to those of the male, but stigma light brown; two minus to two plus postquadrangular cells in the front wing, two in the hind wing; 15 or 17 postnodals in front wing, 14 or 15 in hind wing; in front and hind wings the arculus is distal to the cubito-anal cross-vein about .4 mm., and the anal vein separates from the posterior border about .3 mm. distad to the cubito-anal cross-vein.

Material Studied: Tumatumari, British Guiana, February 11, 1912, one male and one female, the male the type, coll. E. B. W. The specific name refers to the superficial resemblance of this species to certain species in group 2.

Below the falls in the Essequibo at Tumatumari, on the left bank of the river opposite Sprotson's rest house, is a small slow muddy stream. We collected here one day, February 11, taking, among a number of other things, only two specimens of this Heteragrion, which proved to be specifically different from specimens of the same genus taken on the opposite side of the river where most of our collecting was done.

27. *Heteragrion inca* Calvert

Figures 47, 114, 166

Described by Calvert (4) from a male and female in the Hagen collection. The female has since been lost or misplaced. The male is in good condition, but the face is broken so I can not determine the profile. In both front and hind wings the arculus is distal to the cubito-anal cross-vein about .4 mm., and the anal vein separates from the posterior margin from .2 to .3 mm. distad to the cubito-anal cross-vein. The specimens were from Iquitos, Peru. The species is discussed under the next, *icterops*.

28. *Heteragrion icterops* Selys

Figures 117, 118

This species was described by de Selys (1) from a single teneral male from Santarem, Brazil, which lacked the superior appendages. This is the type specimen. Later (2) he noted differences and additional characters of the adult male, and briefly described the female from material from Venezuela, Ecuador, and Peru. Menger's drawings of a male in the de Selys collection is of one of these specimens, but the drawings do not indicate which one. Were it certain that the specimen figured by Menger is conspecific with de Selys' type of *icterops,* I should conclude that *inca* Calvert is a synonym of *icterops.* But I doubt very much that the material from Brazil, Venezuela, Ecuador, and Peru, associated by de Selys under the name *icterops,* is all conspecific. The certain solution of this matter, like other similar questions in the genus, awaits the collecting of more material.

In de Selys' description (2) the abdominal measurement of the female should certainly be 27 instead of 37 mm., unless de Selys referred a female, certainly not conspecific, to this species. Students should not overlook "additions et corrections" to de Selys (2, page 220).

29. **Heteragrion peregrinum,** new species

Figures 6, 7, 52, 53, 59, 73, 96, 167, 168

Abdomen, male 30.5 to 35 mm., average 34; female 31 to 33.5, average 32: hind wing, male 20.5 to 23, average 22 or 22.5; female 23 to 24.

Male.—Rear of head dingy white; genae and pale markings on face, yellow; labrum light to dark reddish brown, anterior edge and a large round median spot, light orange; rhinarium pale, darker above; nasus black, more or less pale at base and at the outer posterior angles; frons pale in front, with a median dark area and dark along the angle; head above variable, due to darkening with age; in even the darkest specimens there are three small pale areas, one in front of the median ocellus on or near the suture between frons and vertex, and one on either side of the median ocellus, not touching the ocellus and extended laterally only to the level of the antenna, the remainder of vertex and frons above black; if a curved line be drawn from either side, beginning at the outer extremity of the pale area on either side of the median ocellus, and curving backward and inward to meet on the median line just anterior to the occipital crest, the roughly semicircular area enclosed is that in which the black is reduced in less mature specimens; this reduction is most conspicuous between and posterior to the lateral ocelli, this area becoming largely reddish brown in some specimens. First joint of antenna black in front; second and third joints light brown, more or less darkened in older specimens, especially on the inner face of the second joint and the apex of the third; remainder brown. Profile similar to figure 64.

Prothorax bright yellow, conspicuous; the front and hind borders black, the latter widened at the lateral extremities and with a large median black spot the length of the hind lobe, or the hind lobe may be black with a yellow anterior spot on either side, or entirely black; a short longitudinal median thread of black on the middle lobe. Propleuron bright yellow, only slightly paler than the middle lobe.

Thorax rather dull colored, black above; on either side of the black middorsal stripe is a dingy white stripe often slightly more than half as wide as the middorsal black, but sometimes reduced to a line; an antehumeral pale, yellowish tinged stripe, about as wide as the dorsal pale stripes, widened on and extending across the mesinfraepisternum; mesepimeron with a wide black bar on its upper two-thirds, not reaching the wing base; remainder of sclerite a livid purplish of varying intensity, often yellowish above, and always darker below, where it is usually a purplish brown, extended across the mesinfraepisternum; remainder of side of thorax varying from purplish flesh to pale dingy yellow; metepisternum with a black bar from the stigma up about half the distance to the wing base; from the stigma a more or less distinct stippled line runs down between the second and third coxae; a more or less distinct line above on the metepimeron. Beneath, coxae and wing bases and immediately adjacent areas lemon yellow, the wing bases with black markings.

Abdomen brown or black marked with dingy white or lemon yellow; segment 1 yellow, the merest trace of a dorsal median dusky spot, lower posterior border black; 2 brown or black above, a pale longitudinal median dorsal line; 3-6 each with a narrow basal pale ring, followed by an extensive dark area, with a more or less distinct pale narrow median longitudinal dorsal stripe, which originates in the pale basal ring and is best developed on the proximal segments; the extensive dark area followed by a reduced pale area, which in turn is followed by an apical black area which is more extensive than the pale area proximal to it, the two apical areas equalling about one-third the length of each segment; 7 is more or less definitely patterned like 6, but the extensive subbasal black area usually shades out indefinitely posteriorly so the apical pattern is lost, that part of the segment being like the following segments; 8-10 dull reddish or yellowish brown, usually progressively darkening posteriorly. Seen from the side, 2 with dorsal third dark, remainder pale, the extreme inferior border dark; 3 similar to dorsal view but the basal and subapical pale areas are joined along the inferior border; 4-6 similar to 3, but in each the basal and subapical pale areas are separated by the lateral extension of the subbasal dark area, this separation progressively longer (i. e., the pale areas below more reduced) posteriorly; 7-10 as in dorsal view, 8-10 with the lower border paler than the dorsum, most distinct on 9 and 10. Superior appendages brown, paler at base, darkening sometimes to black at apex; inferior appendages dull yellow.

Legs light brown or gray, very lightly clouded or shaded with darker; a more or less distinct brown subapical area on each femur.

Wings clear or brownish tinged; stigma dark brown or black, covering from two minus to two plus cells; two to two plus postquadrangular cells in the front wing and two minus to two plus in the hind wing; postnodals in front wing 15 to 18, in hind wing 14 to 16; in the front and hind wings the arculus is distal to the cubito-anal cross-vein from .3 to .5 mm.; in the front wing the anal vein separates distad to the cubito-anal cross-vein from about .4 to .6 mm., in the hind wing from .6 to .8 mm.

Female.—Head similar to that of the male, especially the younger and paler males, and variable as in that sex; the frons above is never black, but varies from light to very dark brown, except at the lateral extremities which are black; the vertex is largely brown, a black area on each side opposite the antenna, a black area in front of and on either side of the median ocellus, between the antennae, and a black occipital crest are always present; the pale area on either side of the median ocellus varies in extent and clearness but is always present; the same is true of the median pale area in front of the median ocellus, except that it is apparently wanting in one specimen; in older specimens the area between the ocelli is largely black. Antenna and profile similar to the male.

Prothorax dingy white to lemon yellow, patterned as in the male, the hind lobe as described for the palest males; the posterior half or more of the middle lobe is more or less indefinitely stippled brown or black. Propleuron white to light yellow.

Thorax patterned exactly like that of the male and only slightly paler, in fact a bright colored female may be brighter than a dull colored male, but in no females does the yellow of coxae and under parts become as bright as in the brightest males.

The abdomen also is practically as described for the male, except that it is slightly duller, the pattern not quite as definite; segment 2 has the lower lateral border pale, not black edged as in the male; 8-10 instead of being progressively darker posteriorly, as in the male, are progressively paler; in some specimens 8 and 9 are more or less black on the sides. Appendages unusually long, .8 to .9 mm., slender, dull yellow or light brown at base, shading apically to dark brown.

Legs as described for the male.

Wings and stigma as in the male; the postquadrangular cells in the hind wings very variable, in the front wings, 15 wings have two postquadrangular cells, and 10 wings have two plus, but in 25 hind wings, 19 have from one to one and a half cells, 6 have two minus and 9 have two cells; postnodals 15 to 18 in the front wing, and 13 to 16 in the hind wing; relations of the cubito-anal cross-vein to the arculus and the separation of the anal vein from the posterior border as in the male.

Material Studied: Cristalina, Department of Antioquia, Colombia, February 12 to 19, 1917, 33 males and 17 females,

J. H. and E. B. Williamson, collectors, coll. E. B. W. Type male and allotype female, February 17, 1917.

We found this species at Cristalina only along the smallest creeks. About half the material of both sexes came from the Quebrada Cristalina and the other half from the small tributary of the Quebrada Sabaleticus, mentioned under the discussion of *Heteragrion calendulum*. It was not taken along Quebrada La Camelia where we took many specimens of *mitratum*. The latter inhabits small streams but gives place to *peregrinum* on the small tributaries and on the headwaters of these streams. *Peregrinum* rests on twig tips or leaf edges. For a Heteragrion it wanders far from water and is found in the brush in shallow short dry gullies between low hills. It is remarkable that the bright yellow prothorax of the male is the conspicuous color area of the insect. This color area is less conspicuous, of course, than the bright yellow "headlights" of the males of *mitratum, calendulum,* etc. *Peregrinum* is an aberrant member of group 3 of the genus, but it can not be placed in any other group. This fact and its habit of wandering from the streams make the specific name doubly appropriate.

A male was sent to Dr. Ris for examination. He wrote: "I have not seen anything similar to this."

30. *Oxystigma petiolatum* Selys

Figures 10, 25, 26, 55, 66, 99, 100, 101, 102, 115, 116, 169, 170

Male.—Labrum black. Prothorax black, extreme anterior border of front lobe bluish and the lateral margin greenish blue; middle lobe with a large anterior indefinite greenish-blue spot on either side reaching the lateral margin; hind border of posterior lobe lavender. Propleuron light yellow, bluish in front, darker behind. The narrow lines on either side of the middorsal thoracic black are clear lemon yellow or yellowish; the antehumeral stripe is bluish with yellow tinges; the mesepimeron is largely brown; the metepisternum is blue above to the stigma, white below and along the anterior border above, a stippled black bar from near the wing base to the stigma; metepimeron almost white, traces of a dark area above. Beneath white, coxae cream. Abdomen black above, including 1, pale basal rings not evident; seen from the side there are more or less distinct pale basal inferior spots on 3-7. Superior and inferior appendages black.

Female.—Prothorax largely light brown, hind lobe darker. Abdomen as described for *cyanofrons*.

Wings in both sexes about as described for *cyanofrons*; the distance from cubito-anal cross-vein to arculus and to the separation of the anal vein from the posterior border slightly greater in all wings in both sexes of *petiolatum*; postnodals in front wing 19 or 20, in hind wing 15 to 18. In the male there are one to one and two-thirds postquadrangular cells; in the female less than one to one postquadrangular cell.

The above notes are intended to supplement de Selys' description of both sexes from Santarem, Brazil. As might be expected some differences in color between the British Guianan and Brazilian specimens are indicated.

Material Studied: Tumatumari, one male, February 9, 1912, and Wismar, one female, January 31, 1912, British Guiana, collection E. B. W.: Tamanoir, Mana River, one male and four females, May, 1917, and Cayenne, two males and one female, February and March, 1917, French Guiana, S. M. Klages collector, collection Carnegie Museum: Igarapi Assei, Para, Brazil, December, 1911, two males, Parrish collector, collection Cornell University: one female, collection E. B. W., without data.

The male taken at Tumatumari was resting on a twig tip in a dry flat near the river where I also took *Metaleptobasis mauritia.*[13] One of the females from Tamanoir, French Guiana, has a remarkable left front wing. The wing is slightly shorter than the opposite wing and there are some abnormalities in the stigma and in veins near the apex of the wing. But the rest of the wing superficially appears normal. However the first antenodal is distal to the first antenodal of the opposite wing about one-fifth or sixth the distance from wing base to antenodal; the second antenodal and the arculus are still more distal; and the nodus still more distal, being distal to the nodus of the opposite wing a distance equal to about one-half the distance from the second antenodal to the nodus: M_3 arises slightly distad to the nodus, at the nodus in the opposite wing; Rs arises near the eighth postnodal, near the sixth in the opposite wing; and M_2 arises near the thirteenth postnodal, near the ninth in the opposite wing. From this point distally the wing area has irregular cell structure and evidences of abnormality. Is there any connection between this apical injury and the relatively apical position of the otherwise normal basal wing structures?

31. **Oxystigma cyanofrons**, new species

Figures 11, 27, 28, 60, 103, 104, 171, 172

Abdomen, male 33 to 36 mm.; female 26 to 27: hind wing, male 22 to 23.5; female 22 to 22.5.

Male.—Rear of head light cream, darker shaded above; genae, labrum, nasus and frons bright blue, labrum more or less bordered with black, stipple-edged; rhinarium largely black with blue areas on either side; vertex black, shining adjoining the eye, opposite the antenna; a short dull blue line or bar from each lateral ocellus toward the antenna, wanting in one male. First joint of antenna more or less blue in front; second joint and basal two-thirds of third, black; remainder brown; the third joint short and robust. Profile similar to figure 66.

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[13] Notes on Neotropical Dragon-flies, Proc. U. S. Nat. Mus., Vol. 48, 1915, p. 603.

Prothorax dark reddish brown to black; anterior border of first lobe narrowly pale; posterior border of middle lobe pale on either side and small indefinite pale areas, sometimes wanting, on either side near the anterior border. Propleuron largely dark or black, some indefinite pale markings above.

Thorax above very dark reddish brown or black, the pale line on either side of the narrow middorsal black, which is almost universal in Heteragrion and Oxystigma, is discernible only as a slightly lighter brown line or is wanting; the same is true of the antehumeral pale stripe; sides dark, obscure and indefinitely patterned; mesepimeron and metepisternum largely dark reddish brown; the lower ends of these sclerites, the adjacent parts, including the coxae, and the metepimeron pale, stippled and clouded with brown or black to a varying degree and in an indefinite pattern; the pale color of the metepimeron is light dull blue or grayish, the other pale parts tinged with yellowish; beneath almost white, bluish.

Abdomen above black, a small subapical pale spot on either side of 1; more or less distinct traces of a longitudinal middorsal pale stripe on 2; scarcely discernible traces of pale basal areas on 3-6. Sides of 1 and 2 with obscure pale markings; 3 with the extreme lower edge pale; 4-7 with an inferior marginal basal pale spot, followed by a dark inferior margin which is followed in turn by a longer narrow pale inferior margin which does not reach the apex; this pattern more or less distinct on 8 which approaches the uniform black of 9 and 10. Appendages black.

Legs dark brown or black; femora more or less obscurely lighter brown, the hind femora the palest.

Wings almost clear or tinged with yellowish brown; stigma brown, very oblique, covering two and one-half to slightly more than three cells; one, or slightly more than one postquadrangular cell; postnodals of front wing are 20 to 23, of hind wing 17 to 19; in the front wing the arculus is distal to the cubito-anal cross-vein about 1.2 mm., in the hind wing about 1.5; in the front wing the anal vein separates from the posterior wing border about 1.5 mm. distad to the cubito-anal cross-vein, in the hind wing about 2 mm. distad.

Female.—Rear of head light cream, darker shaded above; genae and frons dull yellow, the frons the duller; labrum dull green, front border darker; rhinarium black or very dark brown; nasus light dull green, yellowish at the margins and darker in front; vertex as in the male, the pale spots larger and dull yellow. Antenna black or dark brown, only faint traces of paler on the first joint in front. Profile similar to that of the male.

Prothorax reddish brown; first lobe with its anterior border pale edged; an anterior yellow or bluish spot on either side of the middle lobe, and the posterior border on either side yellow or bluish (scarcely discernible in one specimen); hind lobe narrowly pale edged on the posterior border. Propleuron largely cream, a dark superior area.

Abdomen brown above; a more or less distinct narrow median longitudinal pale line on 2; apex of 2-6 more or less distinctly black, and 3-7 with more or less distinct narrow basal pale rings. Seen from the sides 1 and 2 largely pale, darker at apex; 3-6 or 7 with sides below pale, continuous with the pale basal rings and terminating against the apical black areas; on 4-6 this pale area is encroached on subbasally by an indefinite inferior dark brown area, just posterior to the inferiorly dilated basal pale ring, which dark area occupies about one-fourth to one-third the length of each segment; 8-10 largely brown, apex of 8 darker, 9 with a large central area, paler, and 10 shading out below to yellow. Appendages brown.

Legs similar to the male, but paler, the lighter brown more extensive.

Wings similar to those of male, stigma a lighter brown; postnodals of front wing 18 to 21, of hind wing 16 to 17.

Material Studied: Wismar and Tumatumari, British Guiana, February 5 to 16, 1912, three males and two females, collection E. B. W. Type male, Tumatumari, February 5, 1912; allotype female, Wismar, February 16, 1912.

The female taken at Wismar was flying in a dry woods and resting on the tips of twigs. The other specimens were found singly in the woods along the Tiger Creek trail at Tumatumari. They rested on twig tips and were seen with difficulty.

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3. Philip P. Calvert, Biol. Centr.-Amer., Neuropt., pp. 62-65 and p. 357.

4. Philip P. Calvert, Odonata of the Neotropical Region. Annals of the Carnegie Museum, 1909.

5. Philip P. Calvert, The Fossil Odonate Phenacolestes, with a Discussion of the Venation of the legion Podagrion Selys. Proc. Acad. Nat. Sci. Phila., May, 1913.

6. A. S. and P. P. Calvert, A Year of Costa Rican Natural History. The McMillan Company, 1917.

7. F. Ris, Neuer Beitrag zur Kenntnis der Odonatenfauna von Argentina. Mem. Soc. Ent. Belg., 1913.

8. F. Ris, Odonata from the Region of the American Cordilleras between Costa Rica and Catamarca. "An entire installment of the Archiv f. Naturgeschichte." (Letters from Dr. Ris, December 30, 1917, and April 10, 1918. The paper includes a catalogue of the Odonata of Colombia. Dr. Ris had seen proofs of some plates of wing photos when he wrote me in 1917. I have not seen the paper, but Dr. Ris has sent me a copy of that part of the manuscript dealing with Heteragrion.)

9. Helen T. Higgins, The Development and Comparative Structure of the Gizzard in the Odonata Zygoptera. Proc. Acad. Nat. Sci. Phila., January, 1901.

10. George H. Carpenter, The Geographical Distribution of Dragonflies. Scientific Proc. Royal Dublin Society, April, 1897.

A few other references to the genus or to certain species are not of interest in the present study.

APPENDIX

Several weeks after the above paper was completed and sent to Dr. Ruthven for publication, I received a package of separates from Dr. Sjöstedt, one of which[14] contained matter of special interest in this connection. In this paper

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[14] Wissenschaftliche Ergebnisse der—Schwedischen Entomologeschen—Reise des Herrn Dr. A. Roman—in Amazonas 1914-1915—1 Odonata—von Yngve Sjöstedt. Arkiv för Zoologi, Band 11, N. 15.

Dr. Sjöstedt describes three new species of Heteragrion. Unfortunately at this time I had returned the borrowed material upon which much of my own work had been based, and I am therefore unable to study this material again in the light of this new literature.

The species described by Dr. Sjöstedt may be briefly discussed as follows:

Heteragrion silvarum Sjöstedt. One male and two females, Amazonas, Manaos.

Dr. Sjöstedt compares his species with *aurantiacum,* separating it from the latter by its smaller size (a negligible difference), by the relatively longer male superior appendages, each with a relatively larger inferior tooth and with a smaller number of apical spines (this last character probably without value), and by the excavated posterior border of segment 10, which is nearly straight in *aurantiacum.* Unfortunately I cannot now determine how valuable this last character may prove in the genus. The differences noted in the color of head and prothorax of the two species are probably of value in the case of the prothorax only. But in a venational character, pointed out by Dr. Sjöstedt, *silvarum* is entirely distinct from *aurantiacum,*—the cubito-anal cross-vein near the arculus in *silvarum,* and much more proximal in *aurantiacum.*

Dr. Sjöstedt also points out differences in size and color between *silvarum* and *cinnamomeum, macilentum* and *beschkii.* Of the other species of the group not mentioned by Sjöstedt there are none I think to which *silvarum* might be referred, though there is the unidentified but probably larger *amazonicum* to reckon with.

In my key to males of groups 1 and 2 *silvarum* will run out to *aurantiacum* but from Dr. Sjöstedt's description and figure I believe it is more closely related to *ictericum* and *melanurum.* The males of the three species may be separated at once by the color of the apical abdominal segments and the form of the superior appendages.

Heteragrion speciosum Sjöstedt. One male, Peru.

As Dr. Sjöstedt points out. *aequatoriale* and *angustipenne* are the closest relatives of this species. In addition to the darker abdomen it seems to differ from the others also in having a larger ventral tooth on the male superior abdominal appendage. It is certainly different in this latter character from the species so determined and figured by Calvert, but it is not certain that Calvert's *aequatoriale* is that species, and *speciosum* may really be a synonym of *aequatoriale.* The description and the figure of the abdominal pattern of *speciosum* do not agree well.

Heteragrion romani Sjöstedt. One male, Amazonas, Manaos.

Simulatum is very near, possibly the same as this species, but *simulatum* shows only the usual widening of abdominal segments 9 and 10 (the unusual widening may be an accident, due to drying, in the type of *romani*) and these segments are colored as described and are not entirely black above as described for *romani* which moreover seems to be a much duller colored species than *simulatum.* However, Sjöstedt's description is not detailed (the prothorax, brightly colored and sharply patterned in *simulatum,* is entirely omitted) and positive determination is impossible.

On page 5 of Dr. Sjöstedt's paper, eleventh line from bottom, for *Antenodalen* read *Postnodalen*; on page 9, tenth line from the top insert *Flügel* before *Reicht,* and, in the third line above the table of measurements, for *Postcostalen* read *Postnodalen.*

CORRECTION: III, Archaeogomphus, a New Genus of Dragon-flies (Odonata). Occ. Papers Mus. of Zool., Univ. of Mich., No. 63. After *hamatus,* fourth line, page 1, insert the following sentence: a female of another closely related species belonging to the same genus as *hamatus* was briefly described but was not named as the material was considered inadequate.

PLATE I

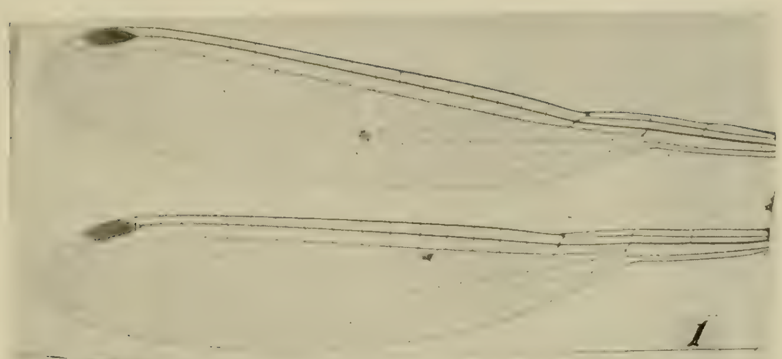
Wing photographs by C. H. Kennedy.

Figure 1, *Heteragrion erythrogastrum,* male, Cristalina, Colombia, February 14, 1917.

Figure 2, *Heteragrion albifrons,* male, Reventazon Valley below Juan Vinas, Costa Rica, June 28, 1909, P. P. Calvert.

Figure 3, *Heteragrion mitratum,* male, Cristalina, Colombia, February 19, 1917.

Figure 4, *Heteragrion mitratum,* female, Cristalina, Colombia, February 14, 1917.



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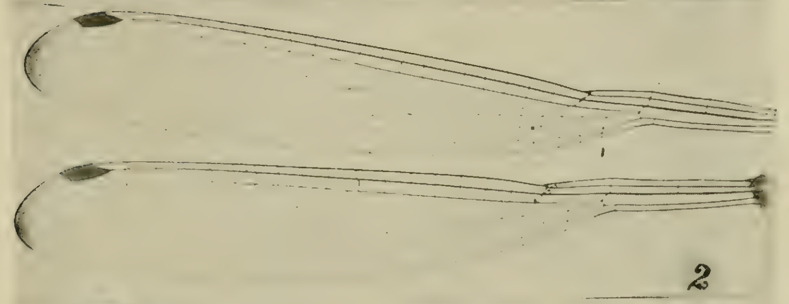

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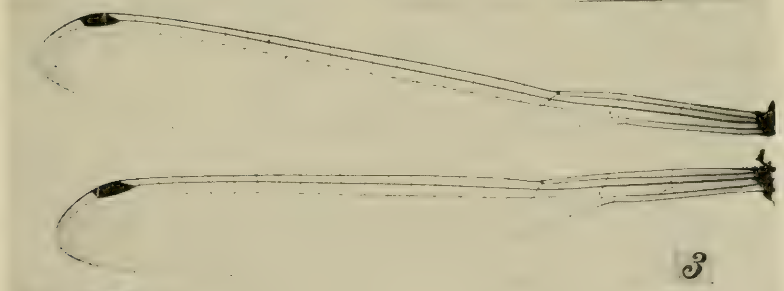

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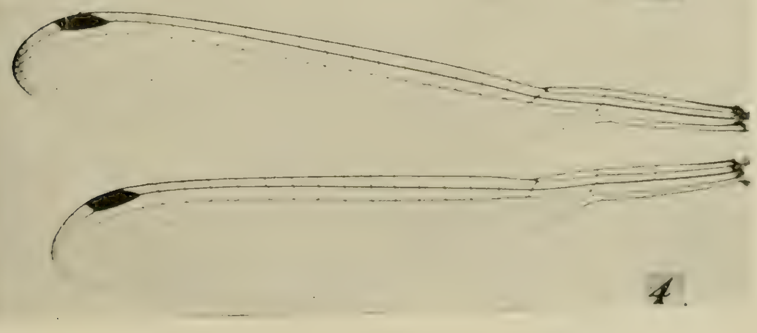

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PLATE II

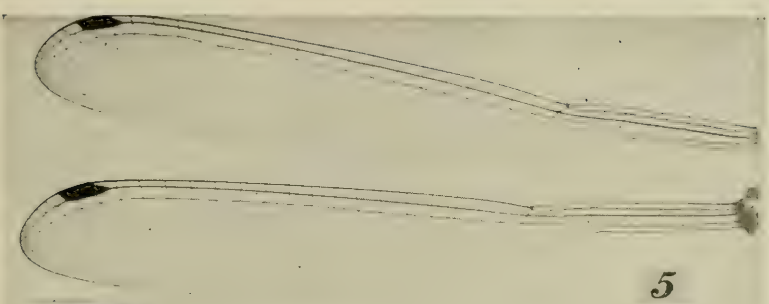
Wing photographs by C. H. Kennedy.

Figure 5, *Heteragrion alienum,* male, Puerto Barrios, Guatemala, June 23, 1909.

Figure 6, *Heteragrion peregrinum,* male, Cristalina, Colombia, February 19, 1917.

Figure 7, *Heteragrion peregrinum,* female, Cristalina, Colombia, February 16, 1917.

Figure 8, *Heteragrion ictericum,* male, Wismar, British Guiana, January 31, 1912.



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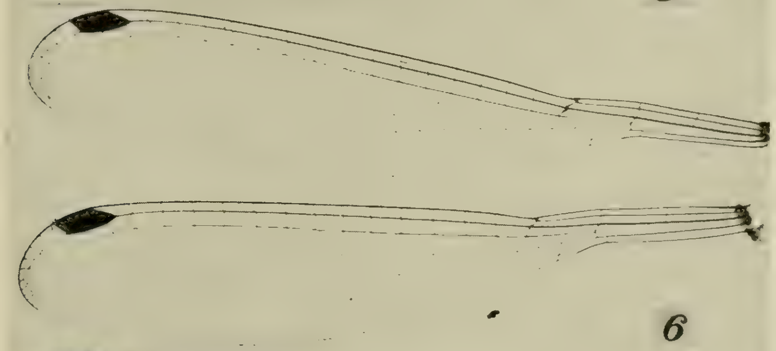

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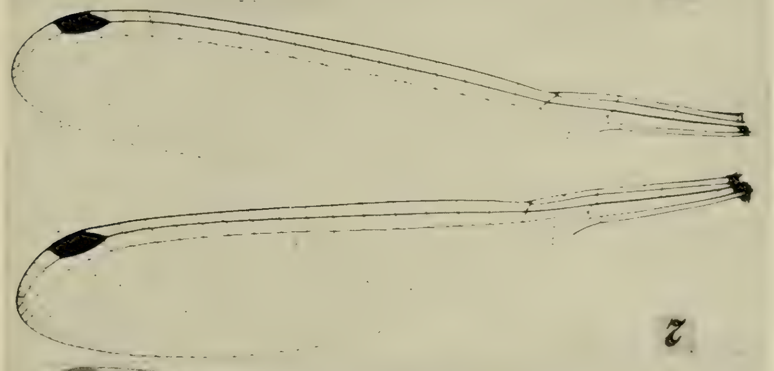

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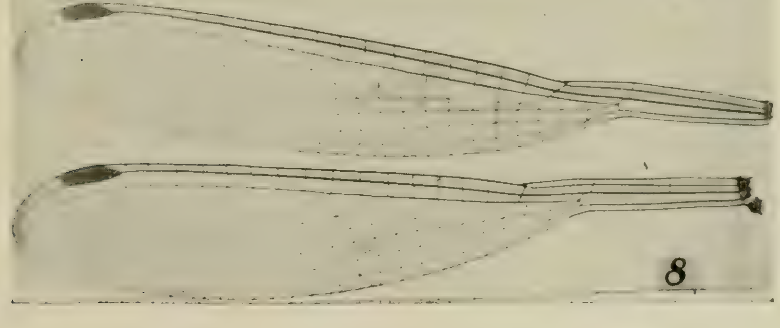

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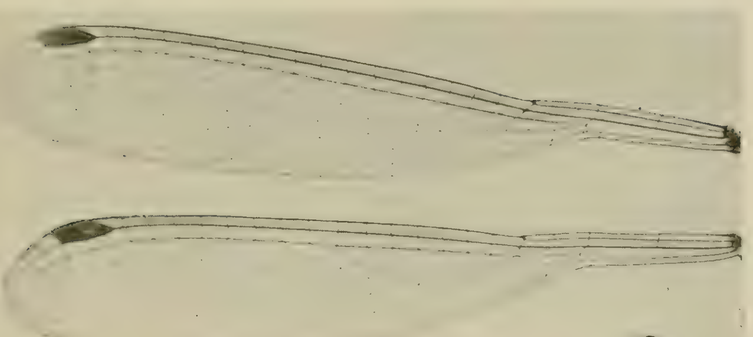
PLATE III

Wing photographs by C. H. Kennedy.

Figure 9, *Heteragrion melanurum*, male, Wismar, British Guiana, January 30, 1912.

Figure 10, *Oxystigma petiolatum*, male, Igarapi, Assei, Para, Brazil, collection Cornell University.

Figure 11, *Oxystigma cyanofrons*, male, Tumatumari, British Guiana, February 5, 1912.



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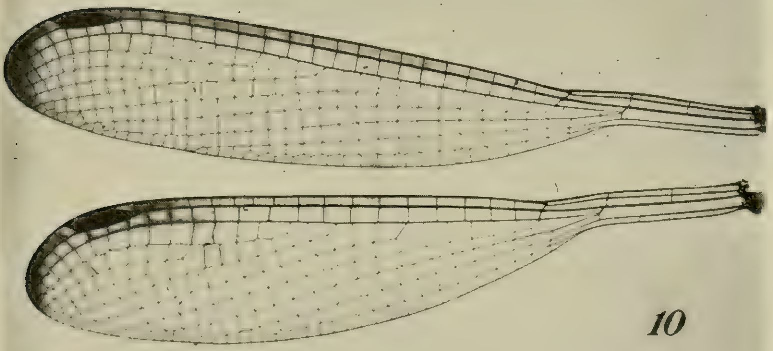

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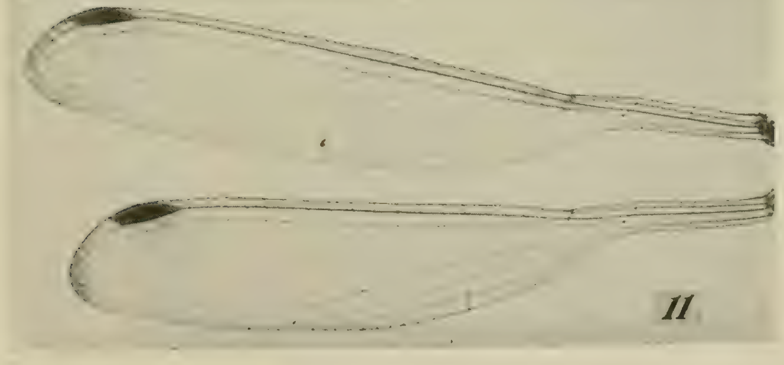

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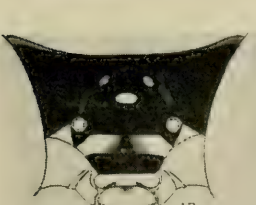
PLATE IV

Diagrammatic patterns of head coloration; figure 29 by Dr. Calvert.

Figure 12, *Heteragrion flavovittatum,* male, and figure 13, female, collection M. C. Z.; figure 14, *Heteragrion ictericum,* type male, and figure 15, allotype female; figure 16, *Heteragrion melanurum,* type male; figure 17, *Heteragrion triangulare,* male, figured by Calvert (4), and figure 18, female, both sexes, collection Carn. Mus.; figure 19, *Heteragrion ochraceum,* female, collection M. C. Z.; figure 20, *Heteragrion beschkii,* male, collection M. C. Z.; figure 21, *Heteragrion aurantiacum,* male, figured by Calvert (4), and figure 22, female, both sexes collection Carn. Mus.; figure 23, *Heteragrion* sp., female, labelled *aurantiacum,* but not that species, collection M. C. Z., see footnote 6; figure 24, *Heteragrion consors,* male, collection M. C. Z.; figure 25, *Oxystigma petiolatum,* male, Tumatumari, British Guiana, February 9, 1912, and figure 26, female, Wismar, British Guiana, January 31, 1912; figure 27, *Oxystigma cyanofrons,* type male, and figure 28, allotype female; figure 29, *Heteragrion angustipenne,* male, figured by Calvert (4).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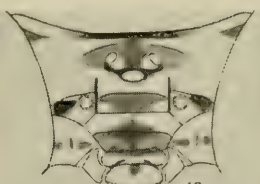
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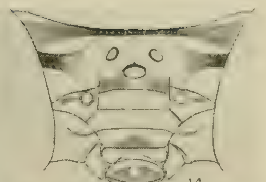
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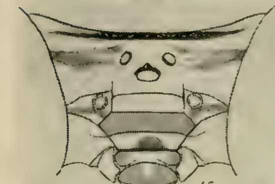
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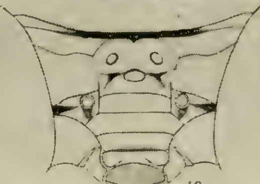
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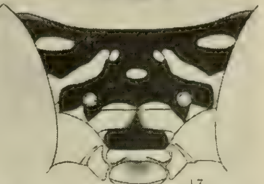
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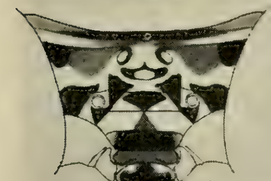
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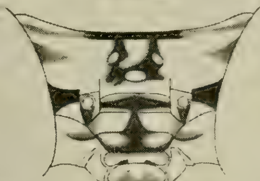
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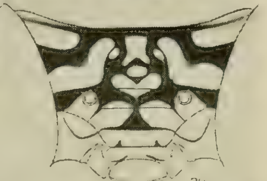
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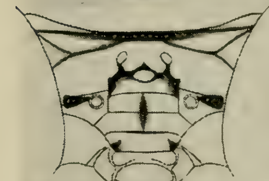
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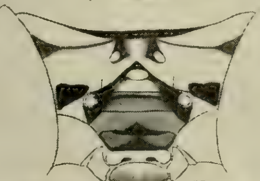
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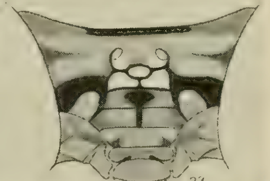
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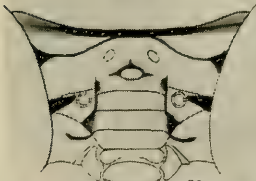
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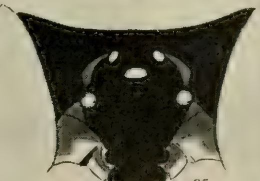
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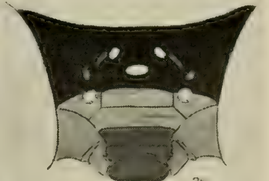
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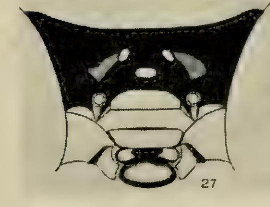
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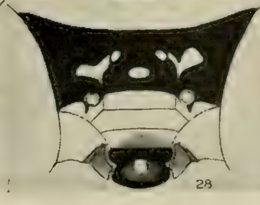
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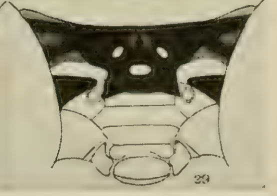
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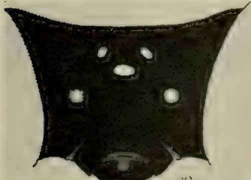
PLATE V

Diagrammatic patterns of head coloration; figures 34 and 41 by Dr. Calvert.

Figure 30, *Heteragrion erythrogastrum,* male, Cristalina, Colombia, February 18, 1917, and figure 31, female, Rio Sardanilla, Canal Zone, December 5, 1916; figure 32, *Heteragrion albifrons,* male, and figure 33, female, both sexes Turrialba, Costa Rica, July 26, 1909, P. P. Calvert; figure 34, *Heteragrion tricellulare,* male, San Geronimo, Guatemala, Champion, collection P. P. C., and figures 35 and 36, male and female, respectively, collection U. S. Nat. Museum; figure 37, *Heteragrion alienum,* type male, figure 39, allotype female, and figure 38, male, Atoyac, Vera Cruz, April, H. H. Smith, collection U. S. Nat. Museum; figure 40, *Heteragrion chrysops,* male, collection M. C. Z.; figure 41, *Heteragrion flavidorsum,* type male; figure 42, *Heteragrion majus,* male, and figure 43, female, both sexes, Cachí, Costa Rica, collection P. P. C.; figure 44, *Heteragrion aequatoriale,* male, and figure 45, very teneral female, both studied by Calvert (4), and in the collection U. S. Nat. Museum; figure 46, *Heteragrion calendulum,* type male; figure 47, *Heteragrion inca,* type male.

PLATE V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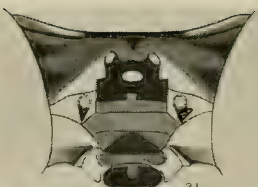
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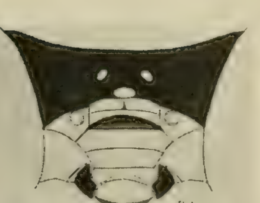
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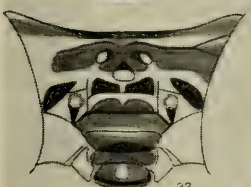
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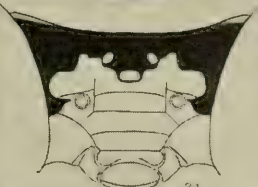
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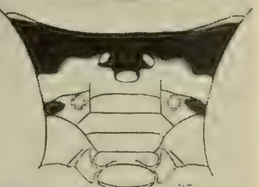
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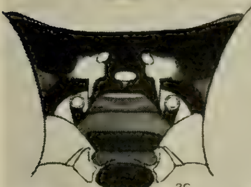
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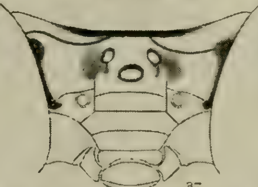
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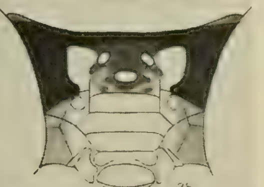
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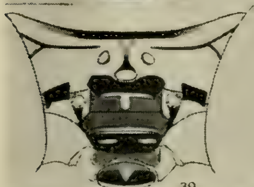
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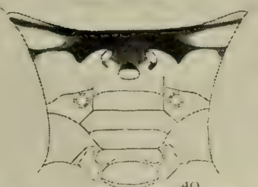
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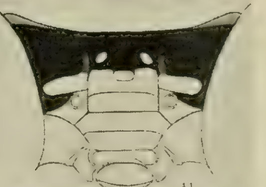
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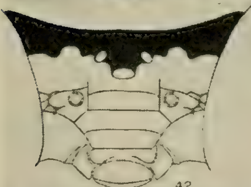
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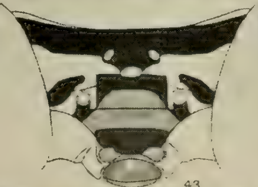
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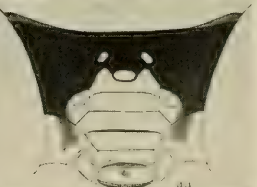
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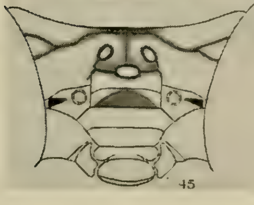
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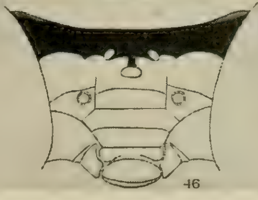
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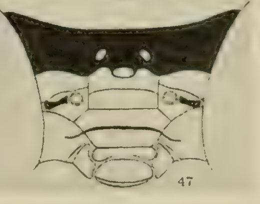
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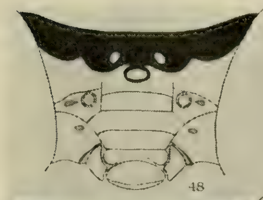
PLATE VI

Figures 48 to 53, inclusive, diagrammatic patterns of head coloration; figures 54 to 62, inclusive, ventral view of genital valves and ovipositors.

Figure 48, *Heteragrion simulatum,* type male, and figure 49, allotype female, very teneral; figure 50, *Heteragrion mitratum,* type male, and figure 51, allotype female; figure 52, *Heteragrion peregrinum,* type male, and figure 53, allotype female.

Figure 54, ventral view of genital valves and ovipositor of *Heteragrion ictericum,* female, Tamanoir, Mana River, French Guiana, June 17, Klages, collection Carn. Mus.; figure 55, same of *Oxystigma petiolatum,* female, Wismar, British Guiana, January 31, 1912; figure 56, same of *Heteragrion mitratum,* female, Cristalina, Colombia, February 13, 1917; figure 57, ventral view of ovipositor of *Heteragrion alienum,* allotype female; figure 58, same of *Heteragrion erythrogastrum,* female, Cristalina, Colombia, February 15, 1917; figure 59, same of *Heteragrion peregrinum,* female, Cristalina, Colombia, February 12, 1917; figure 60, same of *Oxystigma cyanofrons,* allotype female; figure 61, same of *Heteragrion albifrons,* female, Turrialba, Costa Rica, July 26, 1909, P. P. Calvert; figure 62, same of *Heteragrion majus,* female, Cachí, Costa Rica, collection P. P. C.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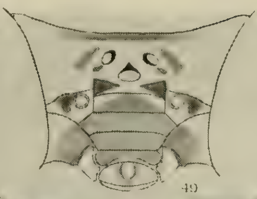
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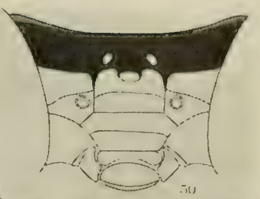
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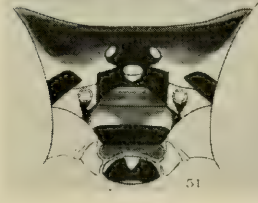
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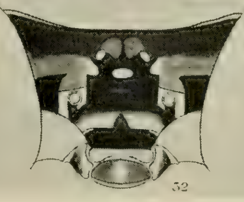
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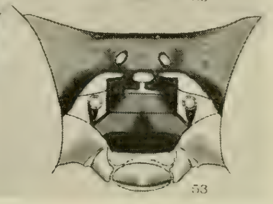
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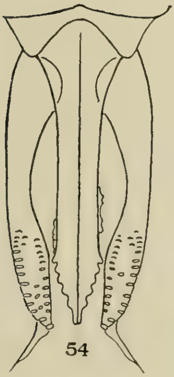
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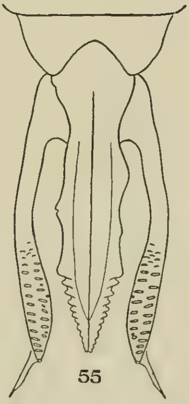
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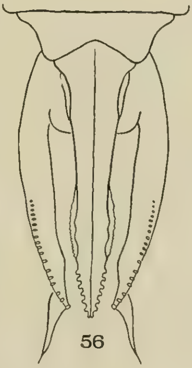
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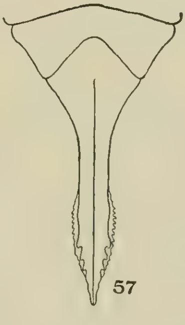
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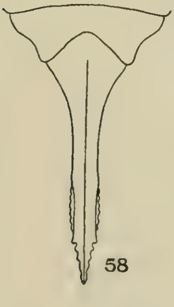
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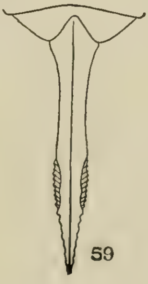
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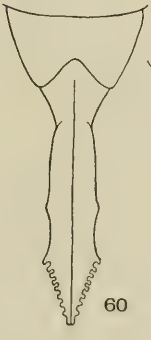
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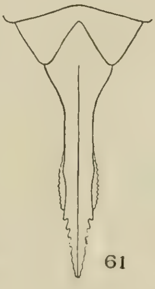
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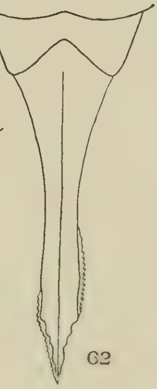
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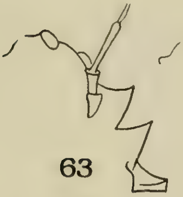
PLATE VII

Figures 63 to 66, inclusive, head profiles; figures 67 to 73, inclusive, female genital valves in profile; figures 74 to 79, inclusive, male abdominal appendages. Figures 74 to 79, inclusive, drawn by C. H. Kennedy.

Figure 63, head profile of *Heteragrion mitratum,* male; figure 64, same of *Heteragrion erythrogastrum,* male; figure 65, same of *Heteragrion icterieum,* male; figure 66, same of *Oxystigma petiolatum,* male.

Figure 67, profile of right genital valve of *Heteragrion majus,* female, Cachí, Costa Rica, collection P. P. C.; figure 68, same of *Heteragrion alienum,* allotype female; figure 69, same of *Heteragrion mitratum,* female, Cristalina, Colombia, February 13, 1917; figure 70, same of *Heteragrion simulatum,* allotype female; figure 71, same of *Heteragrion erythrogastrum,* female, Rio Sardanilla, Canal Zone, December 5, 1916; figure 72, same of *Heteragrion albifrons,* female, Turrialba, Costa Rica, July 26, 1909, P. P. Calvert; figure 73, same of *Heteragrion peregrinum,* Cristalina, Colombia, February 12, 1917.

Figures 74 and 75, oblique dorsal and profile views respectively of the abdominal appendages of *Heteragrion icterieum,* type male; figures 76 and 77, same of *Heteragrion melanurum,* type male; figures 78 and 79, same of *Heteragrion aurantiacum,* State Sao Paulo, Brazil, collection Cornell University.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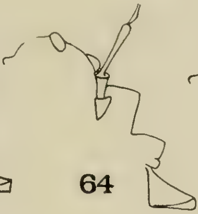
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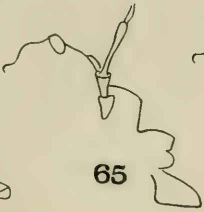
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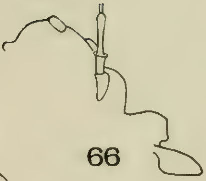
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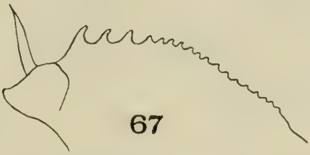
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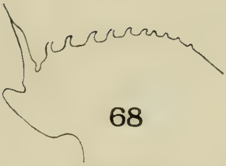
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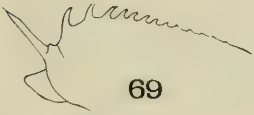
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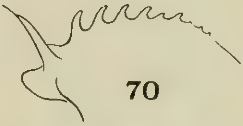
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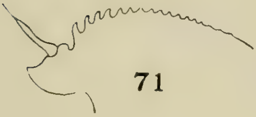
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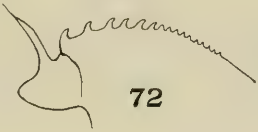
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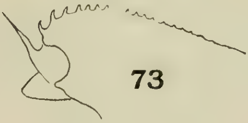
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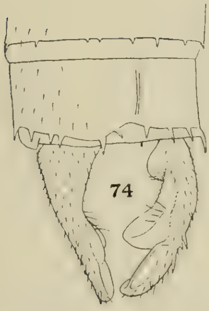
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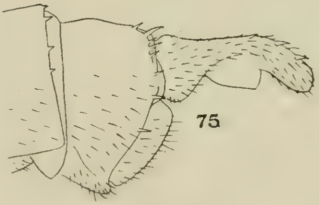
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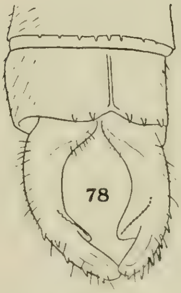
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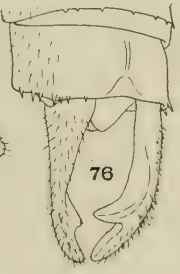
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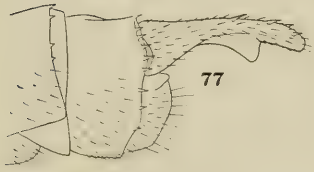
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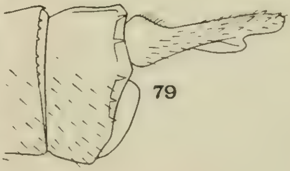
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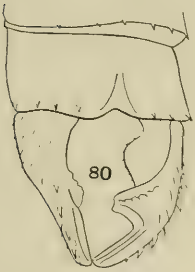
PLATE VIII

Male abdominal appendages; all figures drawn by C. H. Kennedy but figures 90 and 93.

Figures 80 and 81, oblique dorsal and profile views respectively of the abdominal appendages of *Heteragrion consors,* male, collection M. C. Z.; figures 82 and 83, same of *Heteragrion beschkii,* male, collection M. C. Z.; figures 84 and 85, same of *Heteragrion erythrogastrum,* male, Alajuela, Costa Rica, 3100 feet, September 2, 1909, P. P. Calvert; figures 86 and 87, same of *Heteragrion albifrons,* male, Peralta, Costa Rica, September 9, 1909, P. P. Calvert; figures 88 and 89, same of *Heteragrion alienum,* type male; figure 90, oblique dorsal view of the abdominal appendages of *Heteragrion chrysops,* male, collection M. C. Z.; figures 91 and 92, oblique dorsal and profile views respectively of the abdominal appendages of *Heteragrion majus,* male, Cachí, Costa Rica, collection P. P. C.; figure 93, dorsal view of left superior appendage of *Heteragrion aequatoriale,* male, collection U. S. Nat. Museum, for comparison with Menger's drawing, figure 131.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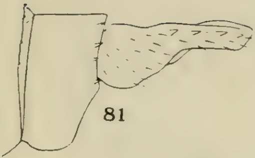
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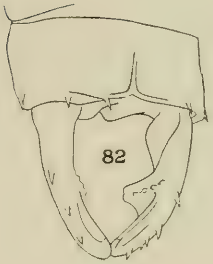
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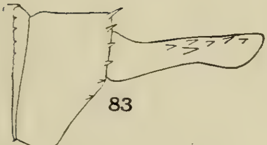
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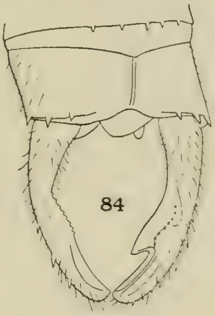
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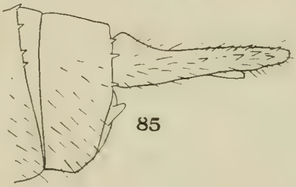
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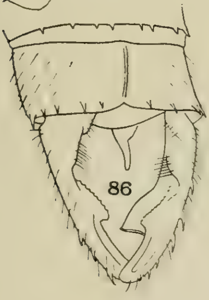
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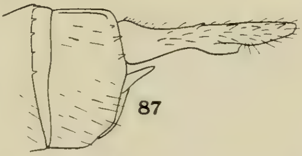
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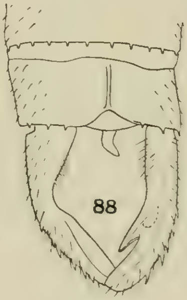
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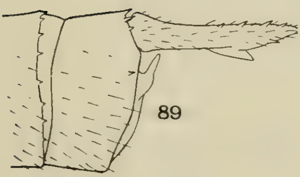
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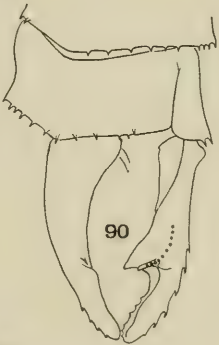
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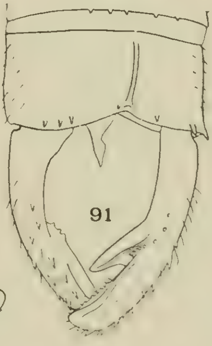
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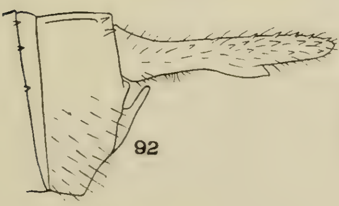
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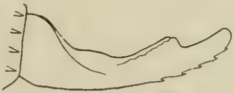
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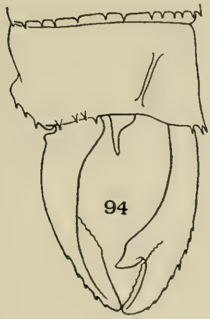
PLATE IX

Male abdominal appendages; all figures drawn by C. H. Kennedy but figures 94, 95 and 96.

Figure 94, oblique dorsal view of the abdominal appendages of *Heteragrion calendulum,* type male; figure 95, same of *Heteragrion mitratum,* type male; figure 96, same of *Heteragrion peregrinum,* type male; figures 97 and 98, oblique dorsal and profile views respectively of the abdominal appendages of *Heteragrion simulatum,* type male; figures 99 and 100, same of *Oxystigma petiolatum,* male, Tumatumari, British Guiana, February 9, 1912; figures 101 and 102, same of same species, Igarapi Assei, Para, Brazil, collection Cornell University; figures 103 and 104, same of *Oxystigma cyanofrons,* type male.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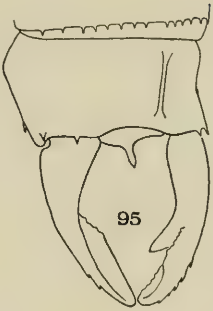
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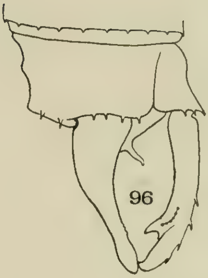
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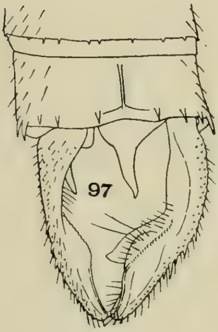
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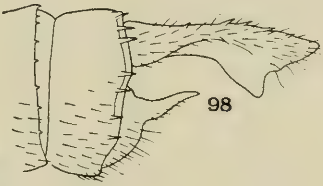
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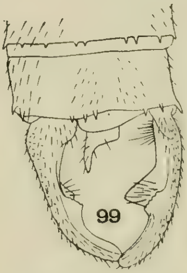
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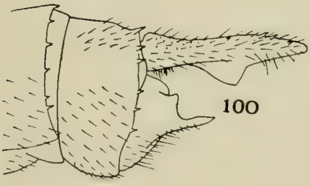
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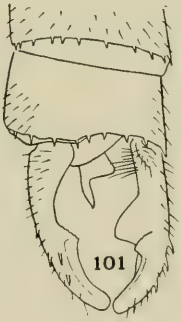
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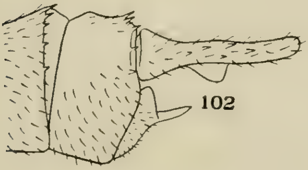
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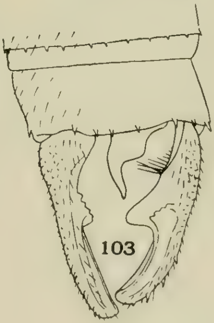
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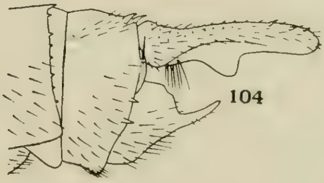
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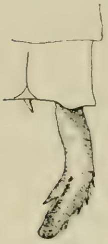
PLATE X

Male abdominal appendages; figures 105 to 107, inclusive, by Mrs. Calvert; figures 108 to 114, inclusive, by Dr. Calvert; figures 115 to 118, inclusive, by Mons. Menger.

Figure 105, oblique dorsal view of the abdominal appendages of *Heteragrion alienum,* male, Calvert's figure 7, plate 5, (3); figure 106, same of *Heteragrion majus,* male, Calvert's figure 6, plate 5, (3); figure 107, same of *Heteragrion tricellulare,* male, Calvert's figure 5, plate 5, (3); figure 108, same of *Heteragrion flavidorsum,* type male, Calvert's figure 41, plate III, (4); figure 109, same, and figure 110, profile of *Heteragrion angustipenne,* male, Calvert's figures 42 and 43, plate III, (4); figure 111, same of *Heteragrion aurantiacum,* male, Calvert's figure 40, plate III, (4); figure 112, same of *Heteragrion triangulare,* male, Calvert's figure 39, plate III, (4); figure 113, same of *Heteragrion aequatoriale,* male, Calvert's figure 37, plate III, (4); figure 114, same of *Heteragrion inca,* type male, Calvert's figure 38, plate III, (4); figure 115 the same, and figure 116, profile view of appendages of *Oxystigma petiolatum,* collection de Selys; figures 117 and 118, the same of *Heteragrion icterops,* collection de Selys.



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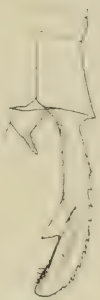

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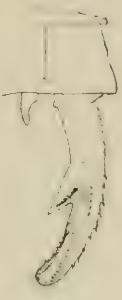

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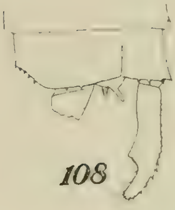

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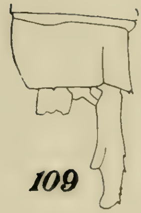

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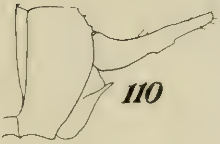

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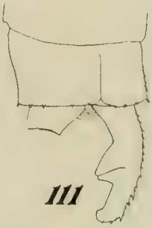

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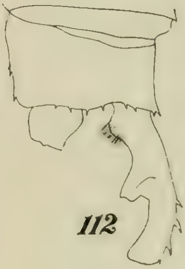

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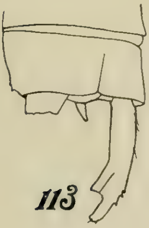

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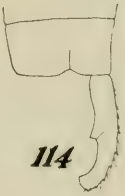

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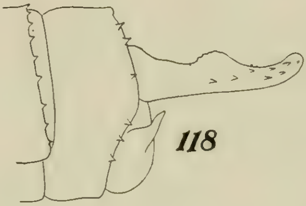

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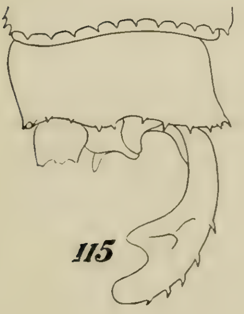

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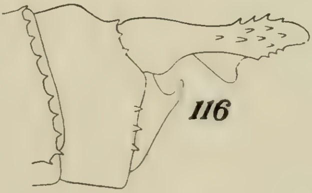

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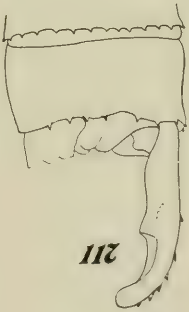

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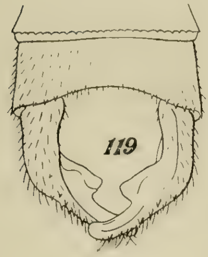
PLATE XI

Male abdominal appendages, all drawn by Mons. Menger from specimens in de Selys' collection.

Figures 119 and 120, dorsal and profile views respectively of the abdominal appendages of *Heteragrion flavovittatum,* male, labelled the same as the male in the M. C. Z.; figures 121 and 122, the same of *Heteragrion aurantiacum,* male, labelled "Cl(Claussen) 3", *"Cinnamomeum?* Hag.", and *"Aurantiacum,* Bresil"; figures 123 and 124, the same of *Heteragrion cinnamomeum,* male, labelled "Schn. Ch. (Schneider-Charpentier)", "Bahia", and *"Heteragrion cinnamomeum* Burm., Bresil"; figures 125 and 126, the same of *Heteragrion erythrogastrum,* male, labelled with species label and "Veragua"; figures 127 and 128, the same of *Heteragrion chrysops,* male, labelled with species label and "P. Cabello"; figures 129 and 130, the same of *Heteragrion majus,* male, labelled with species label, *"crocops",* and "Chiriqui"; figures 131 and 132, the same of *Heteragrion aequatoriale,* male, labelled with species label and "Ecuador."

HETERAGRION PLATE XI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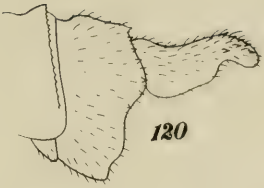
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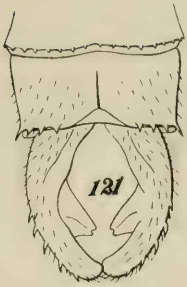
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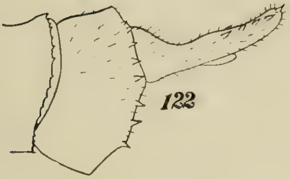
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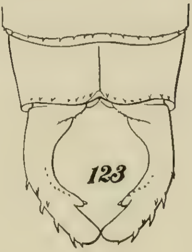
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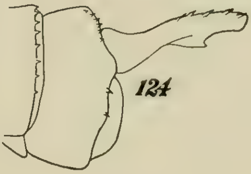
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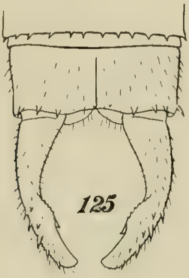
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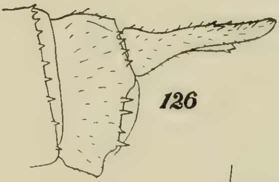
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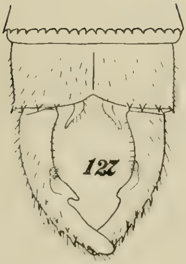
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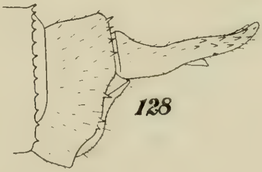
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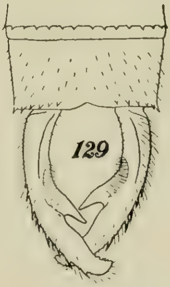
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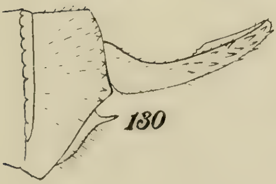
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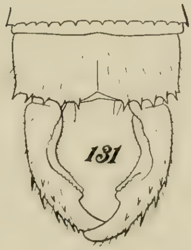
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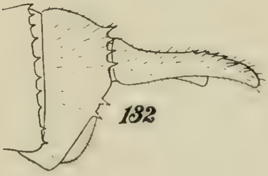
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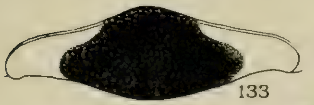
PLATE XII

Hind lobes of the prothorax in dorsal view; figures 155 and 158 by Dr. Calvert. The curve, forming the anterior border of the hind lobe, varies according to the angle at which the lobe is viewed and has no specific significance in the figures.

Figure 133, *Heteragrion flavovittatum,* female, collection M. C. Z.; figures 134 and 135, *Heteragrion ictericum,* type male and allotype female, respectively; figure 136, *Heteragrion melanurum,* type male; figures 137 and 138, *Heteragrion triangulare,* male and female, respectively, both in collection Carn. Mus.; figure 139, *Heteragrion beschkii,* male, collection M. C. Z.; figure 140, female labelled "*aurantiacum,* von Heyer, B. Ayres", in collection M. C. Z., see footnote 6; figures 141 and 142, *Heteragrion aurantiacum,* male and female, respectively, both in collection Carn. Mus.; figures 143 and 144, *Heteragrion aurantiacum,* male and female, respectively, both Sapucay, Paraguay, in collection U. S. Nat. Museum; figure 145, *Heteragrion consors,* male, collection M. C. Z.; figures 146 and 147, *Heteragrion erythrogastrum,* male and female, respectively, male, Cristalina, Colombia, February 18, 1917, and female, Rio Sardanilla, C. Z., December 5, 1916; figures 148 and 149, *Heteragrion albifrons,* male and female, respectively, both Turrialba, Costa Rica, July 26, 1909, P. P. Calvert; figures 150 and 151, *Heteragrion tricellulare,* male and female, respectively, both collection U. S. Nat. Museum; figures 152 and 153, *Heteragrion alienum,* type male and allotype female, respectively; figure 154, *Heteragrion chrysops,* male, collection M. C. Z.; figure 155, *Heteragrion flavidorsum,* type male; figures 156 and 157, *Heteragrion majus,* male and female, respectively, Cachí, Costa Rica, collection P. P. C.; figure 158, *Heteragrion angustipenne,* male, figured by Calvert (4); figure 159, *Heteragrion calendulum,* type male; figure 160, *Heteragrion aequatoriale,* male, figured by Calvert (4), and figure 161, female, same species, both in collection U. S. Nat. Museum; figures 162 and 163, *Heteragrion mitratum,* type male and allotype female, respectively; figures 164 and 165, *Heteragrion simulatum,* type male and allotype female, respectively; figure 166, *Heteragrion inca,* type male; figures 167 and 168, *Heteragrion peregrinum,* type male and allotype female, respectively; figures 169 and 170, *Oxystigma petiolatum,* male and female, respectively, male, Tumatumari, and female, Wismar, British Guiana; figures 171 and 172, *Oxystigma cyanofrons,* type male and allotype female, respectively.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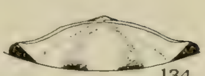
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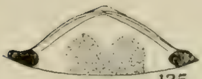
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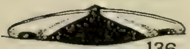
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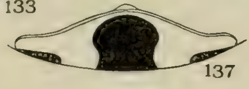
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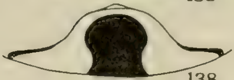
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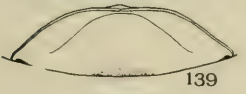
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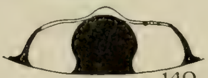
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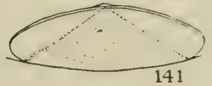
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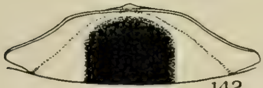
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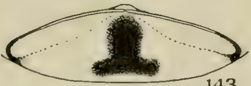
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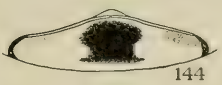
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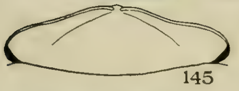
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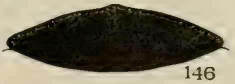
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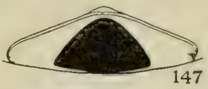
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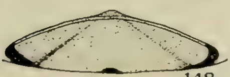
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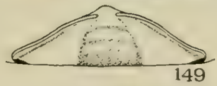
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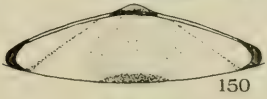
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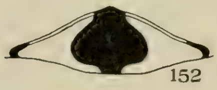
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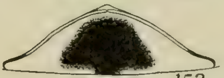
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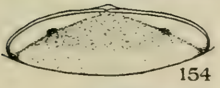
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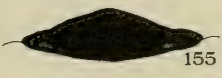
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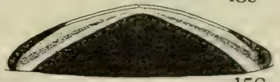
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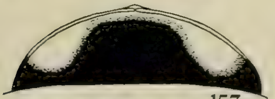
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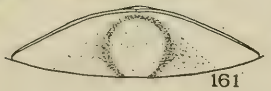
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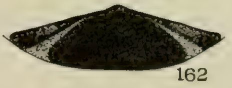
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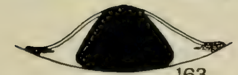
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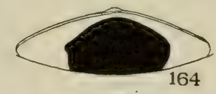
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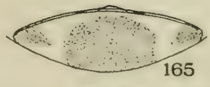
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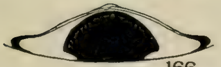
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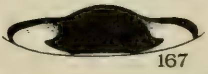
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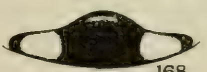
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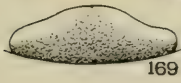
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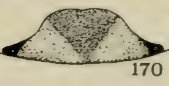
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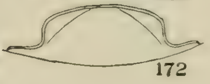
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NUMBER 69 APRIL 25, 1919

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

THE AMPHIBIANS OF THE UNIVERSITY OF MICHIGAN-WALKER EXPEDITION TO BRITISH GUIANA

BY ALEXANDER G. RUTHVEN

The expedition[1] which was sent to British Guiana in the summer of 1914 secured a collection of amphibians which is of interest because of the new locality records, for the data on habits which accompanies it, and for the additional knowledge which it affords of the variability of several species. The party, consisting of F. M. Gaige, the writer, and native assistants, was in the field from July 14 to September 5, and most of the time was devoted to the study of the ants, amphibians, and reptiles.

The area covered by the field work comprised about sixteen square miles on the west bank of the Demerara River about Hyama Creek and the plantation known as Dunoon. The topography of the region consists of low detrital plains along the river, in the rainy season but little above the high tide level, and of ridges of sand reaching a height of 100 feet. The vegetation apparently had been disturbed but little. From the river bank associations (elephant grass, mocca-moccas, and prickly shrubs and palms) to the foot of the sand reefs the lowland was covered with a dense forest among the conspicuous trees of which were the mora, trumpet-tree, tree-fern, and many palms. The clearings were small and widely separated and in many places had been allowed to revert partly or entirely to the forest. The slopes of the sand reefs were also heavily forested but with a more open association, the mora, greenheart and wallabas being the conspicuous trees. On the higher parts of the reefs the forest was composed of tall slender trees (the spar-bush of the natives), of stunted, scraggly trees and bushes about the open areas, or it was replaced by open areas of sand, locally known as mouries. The mouries were covered by a scanty growth of grasses, low bushes, plants with a heath-like growth habit, and xerophytic mosses and lichens, and supported thickets of stunted trees and shrubs (in which the clusias and figs were conspicuous) widely separated or so close together that the open areas formed narrow winding ways.

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[1] An account of this expedition is given in the Annual Report of the Director of the Museum of Zoology for the year 1914-1915.

Unfortunately the breeding season of most of the species of amphibians was apparently over by July 14, but data on the breeding of some forms were obtained. The work was done intensively, an effort being made to obtain as many species as possible and series of specimens of each form with data on habitat distribution and coloration in life. The colors were obtained by comparison with Ridgway's "Color Standards and Color Nomenclature."

LIST OF SPECIES

Cœcilia gracilis Shaw.—Six specimens at Dunoon. The specimens were taken in the forest on the bank of the river; one under a board, the others emerged from the ground when the formalin tanks were emptied.

Pseudis paradoxa (Linnæus).—An excellent series of the species, collected in the summer of 1914, was obtained from Mr. James Rodway, Georgetown Museum. The specimens were taken from the ditches about Georgetown.

Leptodactylus hylœdactylus Cope.—A single specimen taken in low woods at Dunoon, July 29, is referred to this species. It agrees with the descriptions of Cope[2] and Boulenger[3], except that the writer can distinguish neither a dorso-lateral dermal fold nor a cross-band between the eyes.

Leptodactylus typhonius (Daudin).—An adult specimen taken at Georgetown by E. B. Williamson, January, 1912, and six specimens from Dunoon. The latter were all taken in the thickets on the mouries. All of the young specimens (25 mm. or less in length) have a narrow, light, dorsal line enlarging into a spot between the shoulders and otherwise differ in coloration from the adult. The colors in life of one young individual were as follows: Body above brownish olive with dark spots, a narrow capucine orange vertebral stripe enlarged into a spot of the same color between the shoulders, and a flame scarlet stripe on each side; muzzle above tawny olive; fore legs above light orange yellow nearly to feet; hind legs dark olive buff; a Sanfords brown patch on the buttocks. Another specimen was mineral gray above, with orange cinnamon lateral stripes, a cinnamon buff dorsal line, an olive buff spot, and deep olive buff snout.

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[2] Proc. Acad. Nat. Sci. Phila., 1868, p. 115.

[3] Cat. Batr. Sal., p. 240.

Leptodactylus caliginosus Girard.—A large series of specimens. The species was very common at Dunoon and was found only in the low forest, swamps, ditches, and clearings along the river and creeks. During the day it was found under logs, but at night it was active and could be collected in numbers with a light. The coloration is variable but a common type may be described as follows: Ground color above grayish olive with darker markings, the only constant ones being the blackish band from the end of snout to axilla and a large triangular olive brown, black-edged spot on the head; belly white with olive brown reticulations; posterior sides of thighs with an irregular pattern of black and old gold. In some of the specimens the darker markings are faint or wanting, the ground color above being russet with kaiser brown punctulations.

Leptodactylus rhodomystax Boulenger. — Two specimens obtained in the forest on the lower part of the sand reef correspond very closely to the original description of the species. The margin of the upper lip was terra cotta in life, the broad stripe under the eye and the spots at the angle of the mouth, white. The length of the two specimens is 18 mm. and 20 mm.

Lithodytes lineatus (Schneider).—A single specimen taken in a pile of chips in the forest on the sand reef at Dunoon.

Noble[4] has concluded that this species is to be referred to the genus Leptodactylus for the reason that with age there is a change in the form of the distal digital phalange from an "Eleutherodactylus-like T-shaped type" to a "Leptodactylus-like simple type," and a similar change occurs in the ontogeny of a typical species of Leptodactylus, *L. melanonotus*. In the opinion of the writer Noble's argument fails to be convincing when his figures are examined. Drawings B, C, E, F, Figure 1, indicate a reduction in the extensions of the terminal phalanges of *lineatus* with age; but if the phalange reproduced in drawing A is, as stated in the legend, that of an adult specimen of this species the reduction with age cannot be without exceptions. Ignoring drawing A and granting a reduction with age Noble has not shown that the simple condition found in adult Leptodactylids is reached, the adult condition in *L. lineatus* being comparable to the immature condition in Leptodactylids as far as shown by his figures.

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[4] Bull. Amer. Museum Nat. Hist., XXXVII, pp. 793-797.

The writer has examined the phalanges in a series of specimens of *Leptodactylus albilabris* and finds a change in phalange form in this species of Leptodactylus such as Noble describes for *L. melanonotus*: the phalanges are T-shaped, the dilations being blunt in the young and only swollen on the end in the adults. Also in two specimens of *lineatus,* a partially grown individual and an adult, the phalanges are strikingly T-shaped in the young, the expansions being long and attenuated toward the ends, and short and blunt in the adult; in other words, the development is as represented by Noble's figures C and F. It is clear that if the adult form of the phalange in the specimens of *lineatus* now at hand is described as simple, that of the young of Leptodactylus species cannot be called T-shaped, for the change which takes place in the life-history of *lineatus* stops where the similar change in the ontogeny of the Leptodactylus species begins. Quite obviously this does not establish the generic identity of *lineatus* and the species hitherto referred to Leptodactylus, and it seems advisable to consider the former as generically distinct,—at least until it is shown that there are species which have the characters of Leptodactylus and an ontogenetic change in phalange form from a distinctly T-shaped to the simple type. If *lineatus* is referred to the genus Leptodactylus on the basis of our present knowledge, it must be by enlarging the conception of the genus to include both those forms which have simple phalanges in the adult form and those which have at least as T-shaped phalanges in the mature stages as the young of the species now referred to the genus.

The writer believes the conclusion of Peracca[5], that the species represents a genus distinct from Leptodactylus and Eleutherodactylus and allied to Plectromantis, is more nearly correct. It differs from Eleutherodactylus in the shoulder girdle, from Leptodactylus in having T-shaped phalanges in the adult stage, and from Plectromantis in the absence of true pads. It is thus apparently closest to Plectromantis, and it is possible that a study of the phalanges of the latter may reveal that the genera are not to be separated. It is possible also that the species constituting the genus Plectromantis are to be referred to Leptodactylus, as Boulenger has suggested, and in this case it will be necessary to determine if the phalanges change to the same extent as in the species now referred to Leptodactylus or from the distinctly T-shaped, as in young *lineatus,* to the simple type, to decide whether or not *lineatus* goes with them.

The specimen obtained is immature, measuring 28.5 mm. in total length. The ground color of the back and sides, including the head, black; the numerous punctulations olive gray; the lateral stripes primuline yellow; an irregular spot of flame scarlet in the region of the groin extending on the thigh; fore limbs olive gray with black markings; the posterior limbs dark olive gray to the feet, the feet olive gray, the bands black; two large spots beneath the tibia and several on posterior face of femur flame scarlet; chin, throat and chest deep neutral gray with small white spots; abdomen and under surface of hind limbs neutral gray.

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[5] Bol. Musei Torino, XIX, No. 465, pp. 31-32.

Bufo marinus (Linnæus).—This toad was very common in the region about Dunoon. It was found in numbers in the low forest along the river, less abundantly in the forest on the sand reef, and occasionally in the thickets on the mouries. Tadpoles were found in lowland pools in July and August, and some of them left the water on August 16 (Copeia, No. 31, pp. 43-44). The following description of the tadpole has been prepared by Helen Thompson Gaige.

(Museum of Zoology, No. 48285, collected August 4, 1914, by A. G. Ruthven.) Length of body once and a half its width and three-fourths the length of the tail. Nostrils a little nearer eyes than end of snout, distance between them less than interocular space and equal to diameter of eye. Eyes nearer end of snout than spiraculum, distance between them equals width of mouth. Spiraculum sinistral, visible from above and below, equidistant between nostril and insertion of hind leg. Anal opening median, larger than opening to spiraculum. Hind legs well developed, their total length equal to the body width. Tail three times as long as deep, ending in a rounded point; crests narrow, extending halfway to level of spiraculum; depth of the muscular part at the base half the greatest total depth.

Color (in alcohol) grayish black above, brownish black beneath. Muscular portion of tail colored like back above, edged with yellow beneath. Crests grayish translucent.

Mouth bordered by papillae on the sides only. Beak black. Series of labial teeth ⅔, second upper series interrupted in middle by a space one-third of the entire length of the row. Lower rows straight, the outer forming the margin of the lip.

Measurements of six specimens: length of body, 9 mm.;

length of tail, 11, 11, 12, 12, 13, 13 mm., average 12 mm.; width of body, 6 mm.; greatest depth of tail, 4, 4.5, 3.5, 4, 4, 4 mm., average 4 mm.; depth muscular portion tail at base, 2, 2.5, 1.5, 2, 2, 2 mm., average 2 mm.

Bufo typhonius (Linnæus).—A very common species about Dunoon. It was found in all habitats from the thickets on the mouries to the low forest along the river, but it seemed to be most common in the forest on the lower parts and at the foot of the sand reef. There is apparently a considerable sexual dimorphism in size (Plate III) as the largest female measures 79 mm., the largest male, 32 mm. in length. The great variations in coloration are indicated in the following general description made from the living animals. Ground color above usually some shade of brown, sometimes grayish olive or ecru olive, occasionally prussian red; the dark markings (bister, carob brown, warm sepia or black) when fully developed consisting of a preocular band, an interocular band, a shoulder band, a sacral band, and a pelvic band, all interrupted on the vertebral line, some usually wanting or reduced to spots, the sacral and interocular bands most persistent, upper surface sometimes immaculate, occasionally the entire upper surface of head the color of the interocular band; sometimes a vertebral stripe of greenish buff, deep olive buff, cartridge buff or tea green. Sides of body cream buff, deep olive buff or some dark shade of brown (chestnut, carob brown, walnut brown), black, or reddish (orange cinnamon or terra cotta), immaculate or marked with cream buff, ivory yellow or fawn-color. The belly may be immaculate ivory yellow, honey yellow, pale orange yellow, cream buff or cartridge buff, the region of the chest ochre red, burnt sienna, orange cinnamon, ferruginous, Hay's russet, or coral pink; or the under surface may be spotted or washed with cream buff, cartridge buff, deep olive buff, Mikado brown, buffy brown or chestnut drab or black, sometimes to such an extent on the chin and throat that the lighter ground color is reduced to a median line and a transverse line in the pectoral region, and in these specimens the lighter color on the posterior part of the abdomen may be dusky dull violet blue, pale lilac or deep lavender. In our series the females tend to be duller colored than the males, but many of the former had the red ventral colors described above while some of the males did not. It is only in the male specimens, however, that the dorsal band is wide and of a constrasting color.

Hyla maxima (Laurenti).—A large specimen taken in a cocoanut tree at Dunoon on September 5.

Hyla taurina (Fitzinger).—Apparently common in the forest along the river; most frequently observed in the mocca moccas; a single specimen taken in a bromelia in a thicket on a mourie (Plates II and III). The color pattern is variable as the darker markings may occur as stripes, spots, or reticulations and be more or less distinct, but in most of the specimens they take the form of more or less definite stripes from the eyes, and an interocular band is present. The colors of one specimen were as follows: Above dark greenish olive, light spots clove brown, ground color of head ecru olive, light spots above ear and a few on the sides old gold; femur Saccardo umber with bister bands, hind limbs otherwise buffy olive with brownish olive bands; fore limbs olive with faint dusky bands; belly and under surface of legs immaculate white, chin sea foam yellow with sepia spots; iris strontian yellow. Another specimen was snuff brown above except on the head behind the eyes, where it was avellaneous brown; the thighs were Roods brown, the tibia and feet drab; under surface white; iris cream buff. A third was buffy brown on the back and fore limbs, deep olive on the head, and dark olive buff on the hind limbs, with olive brown and clove brown markings; the belly whitish, the ventral spots drab.

The head is usually more olivaceous than the back, and the dark spots on the hind limbs frequently have paler (citrine drab in one) centers.

Hyla helenae, new species[6]

Diagnosis: Habit of *Hyla alboguttata.* Tongue subcircular, nicked and free behind; vomerine teeth between the choanae which are large and in two oblique series forming together a chevron the point of which is directed forward. Tympanum distinct, one-half the diameter of the eye. Fingers with rudiment of web, the disks nearly as large as the tympanum, no projecting rudiment of pollex; toes webbed to penultimate phalange of fourth toe, disks smaller than those of fingers. Head as broad as long; interorbital space broader than upper eyelid; snout shorter than diameter of orbit. Skin smooth above, granular below.

Habitat: Valley of the Demerara River, British Guiana.

Type Specimen: Cat. No. 52681, Museum of Zoology, University of Michigan; Dunoon, British Guiana; August 14, 1914; A. G. Ruthven, collector.

Description of Type Specimen: (Plate I.) Head as broad as long, a little more than one-third of total length. Tongue subcircular, indistinctly nicked and free behind; vomerine teeth in the form of a very open chevron. Head large, depressed, as long as broad; snout rounded, shorter than diameter of eye; canthus rostralis distinct, loreal region concave; interorbital space much wider than upper eyelid. Tympanum distinct, half the diameter of the eye. Fingers with rudiment of web, no projecting rudiment of pollex, disks nearly as large as tympanum; toes webbed to penultimate phalange of fourth toe, disks smaller than those of the fingers, a single metatarsal tubercle, subarticular tubercles well developed. Length of hind leg to tibiotarsal articulation equal to length of body forward to the eye. Skin smooth above, granular beneath.

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[6] Named for Helen Thompson Gaige to whom I am indebted for much assistance in the study of this collection and for the descriptions of the larvae.

Total length 19.5 mm.; head length 7.25 mm.

The colors in life were as follows: Above deep green with numerous well-defined brown spots; thighs, hind feet and inner side of tarsus orange buff, tibiæ javel green; fore limbs, except elbows and inner side of feet, asphodel green, elbows viridine yellow, inner side of fore feet orange buff; both fore limbs and hind limbs with light brown cross-bars; upper lip viridine yellow with vertical brown bars; belly white, immaculate.

In alcohol the green has faded to a brownish olive, the light markings to dull white.

Description of Tadpole: Cat. No. 52517, Museum of Zoology, University of Michigan; collected by A. G. Ruthven. Length of body twice its width and seven-tenths the length of the tail. Nostrils much nearer eyes than snout, distance between them two-thirds interocular space and equal in diameter of eye. Eyes equidistant between end of snout and spiraculum, distance between them equal to width of mouth. Spiraculum sinistral, protruding, visible from above and below, equidistant between posterior border of eye and insertion of leg. Anal opening inconspicuous, dextral in the caudal crest. Hind legs small, their total length equal to the greatest depth of the muscular part of the tail, tips round. Tail almost three times as long as deep, ending in an acute point; crest not wide, not extending on back much beyond the level of the anal opening; depth of the muscular part at base more than half the greatest total depth.

Color (in alcohol) dark brown above with darker irridescent streak down vertebral region, between eyes and on either side. This darker color, spotted with white, encroaches on the sides of the throat. Belly yellowish white, irridescent. Muscular part of tail yellowish with four well-defined square dark spots, becoming progressively smaller posteriorly, on the median line above. Crests gray spotted with black, the spots larger and more numerous on the posterior third of the crest. The square spots may persist until the tadpole is nearly ready to transform; however, one specimen of approximately the same stage of development as 52517 has them only faintly indicated and the crests are immaculate.

Mouth three-fourths bordered by papillae. Beak with wide margin of black. Series of labial teeth ⅔, the second upper series very short, the first widely interrupted in the middle. The first lower series very narrowly interrupted in the middle. Another specimen has only a trace of the second upper series, while a third has only one long, curving, upper series, widely interrupted.

Length of body 14 mm.; length of tail 20 mm.; width of body 7 mm.; greatest depth of tail 7 mm.; depth of muscular portion of tail at base 4 mm.

Remarks: It is with considerable hesitancy that the writer has described this form because the metamorphosed specimens are probably immature. The three adults are, however, very similar in structure and color and are apparently not to be referred to any of the described species. Dr. George A. Boulenger has kindly examined a specimen and has expressed the opinion that the form is allied to *H. alboguttata* Boulenger. The writer has not been able to examine a specimen of *H. alboguttata,* but the specimens here described certainly have many of the characters of that form as given in the original description[7]: the obvious differences are in the width of the interorbital space, the relative length of the snout, and coloration.

Habits: The adults were all taken in the lowland forest along the river. They were on the leaves of ravenalias and cacao. The tadpoles were found in a pool in the same habitat.

Hyla boans Daudin.—Five specimens. The species was found in the forest on the bank of the river. The ground color of the back in a typical specimen was vinaceous russet, the cross bands ecru olive, the head washed above with olive ochre, the region of the groin pale bluish lavender, the lateral dark stripe on head and body blackish brown (3), the anterior face of the tibia blackish brown (3), a line above anus and one on foot ivory white, ventral surface white. In others the ground color was buffy brown on the back and fore legs, the hind legs dark olive buff, the head deep olive, and the dark markings olive brown and clove brown.

Hyla acuminata Cope.—This little tree frog was not rare in low woods at the base of the sand reef near Dunoon, but it was not found elsewhere.

Hyla rubra Daudin.—Numerous specimens from the clearings and forest on the banks of the river at Dunoon. The species was common in this habitat. The color pattern is rather constant, consisting principally of an interocular band, two dorsal bands, a lateral dark band from the eye to the middle of the side, a canthal streak, and pale spots or reticulations on the anterior and posterior sides of the thighs. In life the ground color of the back was lime green, vetiver green, buffy olive or olive brown, the stripes olivaceous black or fuscous; the light spots on the thighs ochraceous buff or primuline yellow; the belly straw yellow, and the chin and throat amber yellow. Some of the specimens had pallid methyl blue, others citron yellow, spots on the groin; one was vetiver green above with olive buff stripes, sea foam green belly, and ochraceous buff spots on the thighs; and one was glaucous above with faint streaks of army brown and a lateral head stripe of seal brown.

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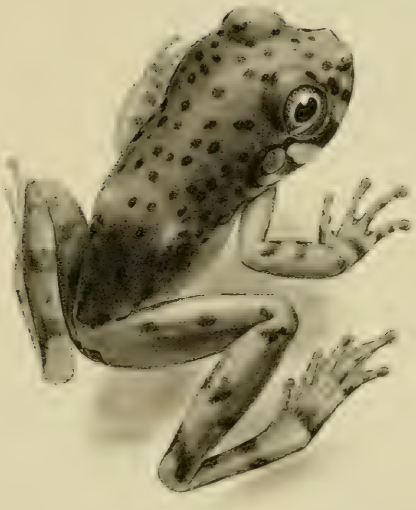
[7] Catalogue of the Batrachia Salientia in the British Museum, p. 356.

Phyllomedusa hypochondrialis (Daudin).—A single specimen was taken in the forest on the north side of the river at Dunoon.

Pipa americana (Linnæus).—There is a specimen in the Museum which was taken at Tumatumari Falls, British Guiana, February, 1912, by E. B. Williamson.



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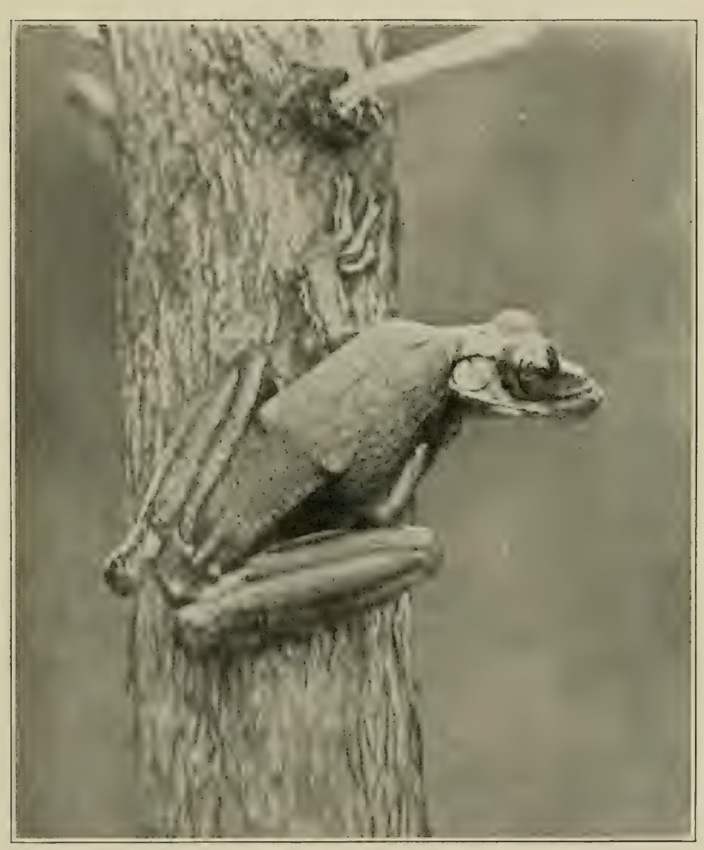
E. N. FISCHER, *del.*

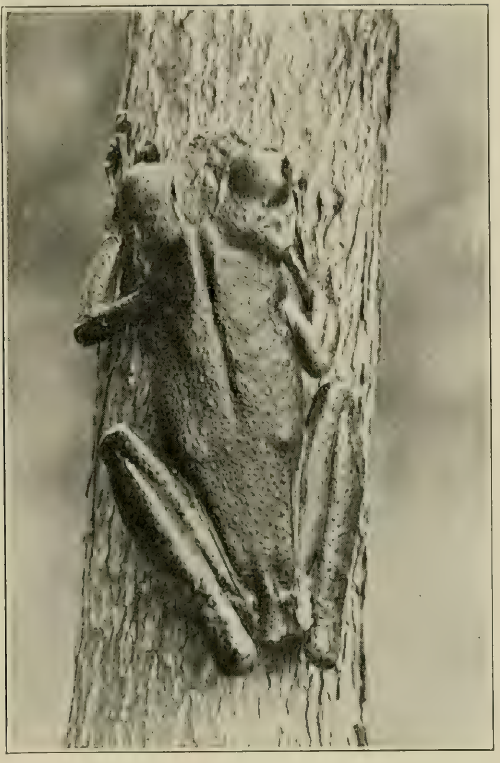
COCKAYNE BOSTON

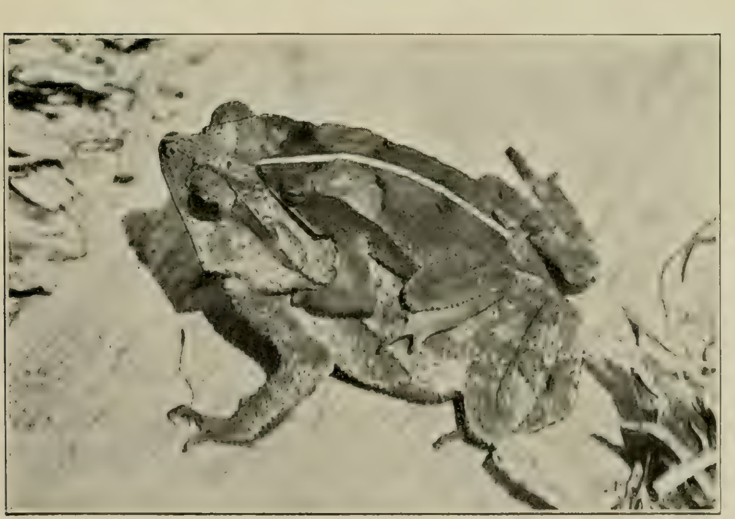
HYLA TAURINA PLATE II



HYLA TAURINA
BUFO TYPHONIUS

PLATE III





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TWO NEW SNAKES OF THE GENUS LAMPROPELTIS

BY FRANK N. BLANCHARD

While making a comparative study of the various forms of the genus Lampropeltis allied to *L. getulus getulus,* it has been found necessary to recognize two new subspecies, as follows:

Lampropeltis getulus floridana, new subspecies

Plate I, Figure 1

Diagnosis: Characters in general like those of *L. getulus getulus* from which it differs in having double the number of transverse light bands, about 60; by a basal lightening of the scales of the dark areas; by a degeneracy of the chain-pattern; and by an increase of one row of scales on each side, making twenty-three.

Range: This form is known only from Florida, south from Orange County.

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Type Specimen: U. S. National Museum No. 22368, female; Orange Hammock, De Soto County (northeast portion), Florida. William Palmer, collector.

Description of Type Specimen: Ventrals, 217, plus one entire anal; subcaudals, 47; dorsal scale rows anteriorly 23, changing, between the 180th and the 192nd ventral plates, to 21 rows (there are actually 24 rows for a very brief space, as from the region of the 101st to 107th ventral an additional row is interpolated between the 5th and 6th); upper labials 7 on each side; lower labials 10 on each side, the last two on the left side very small and underlying the last upper labial, and the 10th on the right minute and interpolated partly above the 9th; preoculars, one on each side; postoculars, two on each side (the inferior the smaller); temporals 2+3+4 on each side; loreal about twice as high as long and about half as high as the preocular; nasals two, the posterior slightly the larger, nostril large and between them; other cephalic shields like those of *L. getulus*; posterior chin shields about equal in length to anterior, parallel and adjacent; four gular scales between posterior chin shields and first ventral.

Total length, 1138 mm.; tail length, 134 mm.; tail divided by total length, .118.

General color in alcohol, brown. About 59 transverse brownish white dorsal bands on body and tail, these extending down on the sides to the level of about the seventh or eighth row of scales. On each side, alternating with these bands, is a similar series of transverse light bands extending upward from about the second or third row of scales to about the seventh or eighth row. Alternating with this series is a row of slightly elongate light spots overlapping the ventral plates and extending upward to about the second row of scales. This latter row of spots is one and one-half scales wide, while the lateral and dorsal cross bars are about one-half to one scale wide. Not infrequently the lateral bars become united with the ventro-lateral spots. Each scale of the dark areas is lightened basally, the light grading distally very gradually to the darkest shade at the distal border of the scale. On the scales that take part in the light transverse bands the change from light to dark is not gradual, but sudden and sharply defined. The series of dorsal, lateral, and ventro-lateral light bars tend to be connected in the chain-pattern style of *L. getulus*. The under side is largely light, but checked with dark chiefly at the sides. Head markings like *L. getulus*; a light spot occupying the centers of the internasals, nasals, loreals, oculars, and tempporals; transverse light bars anteriorly on prefrontals; a light spot anteriorly and medially on supraoculars and frontal; on parietals a light spot at each angle and one or two near the common suture; labials with the anterior and posterior, or with only the posterior, edges dark; rostral and mental edged posteriorly with dark; chin shields and gulars mostly light.

General Description: Besides the type, several specimens have been available for study, and from them the following description has been prepared. Ventrals, 211-226; subcaudals, 42-53; supralabials usually 7, sometimes 8; infralabials, 9 or 10; oculars, 1 and 2; temporals, 2+3+4; posterior chin shields about equal in length to the anterior, parallel and sometimes separated by a scale; loreal rectangular, higher than long or about as high as long, in one specimen fused with the posterior nasal. Maximum number of scale rows usually 23, sometimes 21; formulae 23-21; 23-21-23-21-19; 21-23-21-19; 21-19. Tail .100 to .150 of total length. Pattern similar to *L. getulus*, except that the transverse light bands on the back are about double the number on the latter species, varying from 46 to 75, with an average of 64. In distinction from *L. getulus* the forking on the sides is irregular or obsolete, the cross bands on the back ending abruptly at about the level of the seventh row of scales. Alternating with the dorsal cross bands is a series of transversely elongated light spots, about two scales wide, extending from about the second to the seventh row of scales. Alternating with the latter is a series of light spots about two scales long which overlap the ends of the gastrosteges and the first row or two of dorsal scales. The scales of the light bands are often sharply tipped with black. Furthermore, and in distinction from *L. getulus,* each scale of the dark area has a development of white, beginning at its basal end and spreading distally to cover one-half to three-quarters of its area. This basal lightening of the dark scales may be so pronounced as to greatly obscure the pattern of alternating transverse bands of white. The belly is checked with black and white, the actual colors varying from white to creamy white or yellow, and from black to yellowish brown.

Each branch of the copulatory organ may be described as follows: Strongly bifurcate, the forks one-fifth the total length of the organ; sulcus single, extending over the side of the larger fork, and down the inner side of the V, distal surface smooth, succeeded proximally by a few slightly fringed calyces; short fringes rapidly becoming modified into small spines which increase in size basally, and, one-half way down the organ, stop abruptly; basal half of organ smooth except for a few scattered minute spines, chiefly near the large ones; no spines distinctly enlarged.

The skull is essentially like that of *L. getulus.* A specimen from Orange Hammock, De Soto County, Florida (U. S. N. M., No. 22367) has the following dental characters: maxillary teeth increasing very gradually in size posteriorly, the last three slightly larger than those preceding, 15 on each side; mandi-

List of S

Explanation.—When there are two num
reviations: A. M. N. H.,—American Museu
of W.,—Public Museum of Milwaukee. Le

MUSEUM	NUMBER	LOCALITY
U.S.N.M.	5509	Charlotte Harbor, De Soto County, Fla.
U.S.N.M.	22367	Orange Hammock, De Soto County, Fla.
U.S.N.M.	type 22368	Orange Hammock, De Soto County, Fla.
U.S.N.M.	36478	Widden's Landing, Kissimee River, Fla.
U.S.N.M.	36479	Widden's Landing, Kissimee River, Fla.
U.S.N.M.	36564	Lemon City, Fla.
U.S.N.M.	61276	Florida
A.M.N.H.	5937	Kissimee Prairie, Fla.
A.M.N.H.	5938	Kissimee Prairie, Fla.
A.M.N.H.	5939	Kissimee Prairie, Fla.
A.M.N.H.	5940	Kissimee Prairie, Fla.
A.M.N.H.	6935	Orlando, Orange Co., Fla
P.M.ofW.	621	Gotha, Fla.
P.M.ofW.	622	Gotha, Fla.
		Vero, St. Lucie Co., Fla.

List of Specimens of *Lampropeltis getulus floridana*

Explanation.—When there are two numbers in one space, the upper refers to the left side, the lower to the right. Abbreviations: A. M. N. H.,—American Museum of Natural History; U. S. N. M.,—United States National Museum; P. M. of W.,—Public Museum of Milwaukee. Lengths are in millimeters.

MUSEUM	NUMBER	LOCALITY	SEX	SCALE FORMULA	VENTRALS	SUBCAUDALS	SUPRALABIALS	INFRALABIALS	OCULARS	TEMPORALS	TOTAL LENGTH	TAIL DIVIDED BY TOTAL LENGTH	CROSS BANDS
U.S.N.M.	5509	Charlotte Harbor, De Soto County, Fla.	Male	23-21-23-21-19	222	43	8	10	1-2	2-3-4	1450	.110	50
[illegible]	22367	Orange Hammock, De Soto County, Fla.	Male	21-23-21-19	222	..	7	9	1-2	2-3-4	Tail imperfect	To	vent 70
U.S.N.M.	type 22368	Orange Hammock, De Soto County, Fla.	Female	23-21	218	47	7	10 9	1-2	2-3-4	1155	118	59
U.S.N.M.	36478	Widden's Landing, Kissimee River, Fla.	Male	21-23-21-19	219	52	7	9	1-2	2-4-4 2-3-4	1612	122	74
U.S.N.M.	36479	Widden's Landing, Kissimee River, Fla.	Female	23-21-23-21-19	215	42	7	9	1-2	2-3-4	1074	107	65
U.S.N.M.	36564	Lemon City, Fla.	Male	21-23-21-19	223	53	7	9	1-2	2-3-4	Skin of adult	.	75
U.S.N.M.	61276	Florida	Male	21-23-21-19	218	48	7	9	1-2	2-3-4	1392	137	55
A.M.N.H.	5937	Kissimee Prairie, Fla.	Female	21-23-21-19	217	50	7	9	1-1	2-3-4	1114	122	60
A.M.N.H.	5938	Kissimee Prairie, Fla.	Male	21-22-21-19	221	52	7	9	1-2	2-3-4	1551	125	76
A.M.N.H.	5939	Kissimee Prairie, Fla.	Male	21-19	226	52	7	9 10	1-2	2-3-4	1443	118	Obsolete
A.M.N.H.	5940	Kissimee Prairie, Fla.	Male	21-19	223	46	7	9	1-2	2-3-4	1031	123	Obsolete
A.M.N.H.	6935	Orlando, Orange Co., Fla.	Female	21-23-21-19	216	46	7	10	1-2	2-3-4	1600	124	56
P.M.of W.	621	Gotha, Fla.	Male	23-21-23-21-19	222	53	7	9	1-2	2-3-4	841	146	49
P.M.of W.	622	Gotha, Fla.	Female	21-23-21-19	212	43	7	9	1-2	2-3-4	954	124	57
		Vero, St. Lucie Co., Fla.		23-21-23-21-19	211	dry	skin						52

bular teeth somewhat larger anteriorly, decreasing in size posteriorly, sixteen on each side; palatines strong, subequal, 19 on the left side and 17 on the right.

The largest specimen examined was from the Kissimee River, Florida, and measured 1612 mm.

Affinities: That this form is most closely allied to *L. getulus* is plainly evident from its form, proportions, markings, copulatory organ, skull, and scutellation. Its pattern is obviously derived from that of the latter by an obliteration of the narrow forks on the sides, and an increase in the dorsal and lateral white markings. It is uncertain just how this pattern was derived; but some of the specimens indicate that it may have taken place by the development of new transverse bands from the white central scales midway between the original bands, and by a splitting into two of each white blotch in the ventrolateral series; or the increase in number of cross bands may be principally due to a shortening of the dark interspaces. Correlated with the increase in number of white cross bars there occurs a lightening of each dark scale which began near its base and extended from there basally, and then distally, until all the area of these scales, except the distal margin, was lightened. The isolation of this form in the peninsula of Florida, the fact that no *Lampropeltis* is known from the West Indies, and the juxtaposition of its range to that of typical *L. getulus* allows of derivation from the latter species only.

Remarks: The form here named *floridana* has hitherto been included under the name of *L. getulus*. The striking differences between some of the specimens from southern Florida and the typical form from northern Florida and the other Atlantic States has not been unnoticed. Loennberg (Proc. U. S. Nat. Mus., Vol. 17, 1894, pp. 324-5) found examples of this subspecies in southern Florida, but considered them only as atypical *L. getulus*. A. E. Brown (Proc. Acad. Nat. Sci., Phila., 1904, p. 472) said that "while no subspecific distinction is warranted, most Florida examples of *Ophibolus getulus getulus,* which is the most vigorous and extended species [of Ophibolus], seem to be rather generalized in the character of the dorsal spots and bands, as between the northern species of the same form and the Louisianan *O. getulus sayi.*" Ditmars (The Reptile Book, 1907, pp. 359-360) says "the jet-black specimens from the northern portion of the range [referring to *L. getulus,* with their vivid white markings] are in strange contrast with pale, greenish specimens without bands, from Florida, but a varietal name would be inappropriate as every degree of connecting variations may be found in a large series of specimens." However, the fact that typical *L. getulus* appears to be entirely replaced in the southern half of Florida by an allied form which differs from it in numerous essential respects makes it clear to the writer that a "varietal name" is not only appropriate, but necessary.

Lampropeltis getulus yumensis, new subspecies

Plate I, Figure 2

Diagnosis: In scalation, proportions, and pattern, essentially like *L. getulus boylii,* from which it differs in that the scales of the light areas are shaded basally with brown, thus giving a spotted appearance to the light annuli. From this form and from *L. getulus conjuncta* (Cope) of the Cape Region of Lower California (with which it has been confused) it may be distinguished by the fact that the white bars on the prefrontal plates are oblong and occupy not more than one-half the area of these scutes, instead of being convex behind and occupying nearly all their area. Furthermore, in *L. getulus conjuncta* the infralabials are usually 10, and in *L. getulus yumensis* they are usually 9.

Range: The southern third of Arizona (except the portion south and east of Tucson), extreme southeastern California, and the desert region about the head of the Gulf of California.

Type Specimen: U. S. National Museum No. 61318, male; 27 miles west of Indian Oasis, Pima County, Arizona; collected by A. B. Howell, July 7, 1918.

Description of Type Specimen: In general with the characteristics of *L. getulus boylii*. Ventral plates, 230, plus one entire anal; subcaudals, 52 pairs; 7 upper and 9 lower labials on each side; one pre- and 2 post-oculars on each side, of the latter the more ventral is the smaller; temporals, on each side, two in the first row and three in the second. Loreal a little longer than high, the upper posterior angle broadly obtuse, the lower acute. Posterior chin shields a little more than half the length and width of the anterior, and separated from each other by two smaller scales. Other cephalic shields normal. Scale rows anteriorly 23 (one less on the left side between the 24th and 34th ventrals and on the right between the 21st and 26th), changing, at about the level of the 146th ventral on the left side and the 140th on the right, to 21, and, at the level of the 182nd ventral, to 19, the formula being thus 23-21-23-21-19.

Total length 1060 mm.; tail length 134 mm.; tail length divided by total length .127.

General color (hardened in formalin and preserved in alcohol) black or very dark brown. From head to tip of tail the body is crossed by 37 white annuli, the scales of which are white with dark brown at the bases. Three scales close behind the parietals have each a white dot. The first complete ring is about twelve scales behind the parietals. The four or five succeeding rings are split on the middorsal line and alternated. The annuli are from one-half to one scale wide on the middorsal line, increasing to about three or four scales wide on the first row of scales. The basal shading is not evident on a few of the lower scales, but is usually conspicuous and often occupies as much as half the area of a scale. The belly presents the appearance of being checkered with large quadrate black and white areas. This is due to the fact that the black and white annuli often partly, and sometimes completely, alternate with each other. The white ventral scutes are usually dark brown at the base, and this shading is progressively intensified posteriorly. The ground color of the head is black. Across the prefrontals and internasals is a broad transverse bar of white; the rostral is white with a black border on the sides and above; the nasals, loreals, oculars, first two left temporals, and upper first right temporal have each a white center; the lowest temporals of the second rows each have a white spot; there is a white spot, antero-ventrally, on each supraocular. The contiguous edges of the labials and of the chin shields are black. The common black borders of the third and fourth and of the fifth and sixth upper labials are much widened.

General Description: On the numerous other specimens at hand the following description has been based: Ventral plates 216-241; subcaudals 44 to 57 (males, 50-57, average 54; females 44 to 51, average 48); supralabials 7 (rarely 8); infralabials 9, sometimes 10; oculars 1 and 2; temporals usually 2+3+4; posterior chin shields but little more than half as long and half as wide as anterior, and separated from each other by two small scales; loreal longer than high. Dorsal scale rows usually 23-21-19, sometimes 23-25-23-21-19 or 23-21-23-21-19. The tail varies from .09 to .14 of the total length (males, .121 to .132, average .127; females, .093 to .128, average .117). The whitish annuli vary in number from 29 to 45, the average being about 37.

This form seems not to differ in size or proportions from *L. getulus boylii.* The largest specimen examined was from the Graham Mts., Arizona, and measured 1204 mm.

Each branch of the copulatory organ is bilobed; the sulcus spermaticus is single, passes over one of the lobes, and ends in a small smooth area at the apical end of the organ. The calyces are few, their fringes fairly conspicuous or very short; the latter pass into spines, which increase gradually in size until about one-third the way toward the base of the organ. Here they stop suddenly, and, over about one-half the distance from here to the base, numerous minute spines may be barely distinguishable. The basal portion is smooth. No spines are distinctively enlarged or isolated from the others.

The skull is like that of *L. getulus boylii.* The dentition is as follows: maxillaries commonly 13 to 14; mandibulars 14 to 17; palatines 9 or 10; pterygoids 12 to 19; anterior mandibulars larger than posterior; last two maxillaries somewhat stouter than those preceding.

The pattern, like that of *L. getulus boylii,* is of white rings on a black ground color, but, unlike the latter, the white scales of these rings are marked basally with brown, which sometimes extends irregularly over the scales so as to greatly obscure the rings. The latter are narrow on the back, one to two and a half scales in width, widening on the sides to about two to five scales, and traversing the belly. As with other forms having the metamoric pattern, the rings may be broken on the middorsal or midventral line and alternated for a greater or less distance, instead of united.

The white bars across the prefrontals and internasals, which are characteristic of all the forms allied to *L. getulus boylii,* occupy here not more than half the area of their respective head plates. Beneath the eye there is usually a rather conspicuous enlargement of the dark border common to the third and fourth upper labials. Markings on the posterior portion of the head are infrequent.

The belly is usually crossed by the continuations of the black and white rings, but, like the dorsal white scales, the white ventral plates are usually conspicuously edged basally with dark brown. Rarely the belly and head are without white markings.

Affinities: This form intergrades with *L. getulus splendida* (Baird and Girard) in the vicinity of Tucson, Arizona, and east and south of there. In the region of the Florence River, in Arizona, it passes into *L. getulus boylii* (Baird and Girard), and in Imperial County or eastern San Diego County, California, it like-wise intergrades with this form.

Remarks: Heretofore *yumensis* has been regarded as practically identical with examples from the Cape Region of Lower California, named by Cope *conjunta* (Proc. Acad. Nat. Sci., Phila., 1862, pp. 301-302). This resemblance is, however, only apparent. Examination of all the material available has made it clear to the writer that these two forms need never be confused, that indeed they are not even related directly,—only through *boylii* can *conjuncta* be derived from *yumensis*.

Its distinctness from *conjuncta* will be more clearly brought out in a subsequent review of the genus, but it may be well to point out here (1) that the range of *conjuncta* is separated from that of this form by an extension of the range of *boylii* into Lower California at least as far south and east as the San Pedro Martir Mountains; (2) that *conjuncta* shows closer affinities with *boylii* than with this form in the pattern and scalation of the head, and in the fact that its young are indistinguishable in the coloration of the white rings from the young

LIST OF

Explanation.—When there are twc right. Abbreviations: U. of C.,—Univ States National Museum; A. N. S.,—A igan; S. U.,—Stanford University. Len

MUSEUM	NUMBER	LOCALITY
U.S.N.M.	4284	Ft. Yuma, Calif.
U.S.N.M.	15969	Yuma, Ariz.
U.S.N.M.	21720	San Domingo, Sono M
U.S.N.M.	37532	Volcano Lake, L. C.
U.S.N.M.	37534	Yuma, Ariz.
U.S.N.M.	44530	Yuma, Ariz.
U.S.N.M	51761	Ash Creek, Graham Mts., Ariz.
U.S.N.M	54717	San Carlos Ind. Res Calva, Ariz.
U.S.N.M.	type 61318	27 miles W. of India Oasis, Pima Co., A
U. of C.	1836	Colorado River, 10 below Cibola, Ariz.
U. of C.	1837	Colorado River at Pilot Knob, Calif.
U. of C.	1838	Colorado River, 5 N. E. of Ft. Yuma,
U. of A.		Tucson, Ariz.
U. of A.		Yuma, Ariz.
U. of M.	52252	Tucson, Ariz.
A. N. S.	3574	Ft. Yuma, Calif.
S. U.	1710	Ft. Lowell, Ariz.
S. U.	4004	Ft. Grant, Graham

LIST OF SPECIMENS OF *Lampropeltis getulus yumensis*

Explanation.—When there are two numbers in one space, the upper refers to the left side, the lower to the right. Abbreviations: U. of C.—University of California; U. of A.—University of Arizona; U. S. N. M.—United States National Museum; A. N. S.—Academy of Natural Sciences of Philadelphia; U. of M.—University of Michigan; S. U.—Stanford University. Lengths are in millimeters.

MUSEUM	NUMBER	LOCALITY	SEX	SCALE FORMULA	VENTRALS	SUBCAUDALS	SUPRALABIALS	INFRALABIALS	OCULARS	TEMPORALS	TOTAL LENGTH	TAIL DIVIDED BY TOTAL LENGTH	RINGS
U.S.N.M.	4284	Ft. Yuma, Calif.	Female	23-25-23-21-20	241	50	7	9	1-2	2-3	1005	.116	39
U.S.N.M.	15969	Yuma, Ariz.	Male	23-21-23-21-19	229	52	7	9	1-2	irregular 3-4 2-[illegible]	932	.121	41
U.S.N.M.	21720	San Domingo, Sonora, Mexico	Male	23-21-19	232	55	7	9	1-2	2-4	1394	.125	38
U.S.N.M.	37532	Volcano Lake, L. C.	Female	23-21-19 --	231	44	7	9	1-1	2-3	skin of adult	....	36
U.S.N.M.	37534	Yuma, Ariz.	Female	23-25-23-21-19	237	49	7	?	1-2	2-3	410	.120	42
U.S.N.M.	44530	Yuma, Ariz.		23 specimen incomplete			7	9 10	1-2	2-3			
U.S.N.M	51761	Ash Creek, Graham Mts., Ariz.	Female	23-21-19	326	47	7	10 9	1-2	2-3 1-3	1204	.118	30
U.S.N.M	54717	San Carlos Ind. Res., Calva, Ariz.	Male	23-21-19	223	55	7	9	1-2	2-4 2-3	skin of adult	....	33
U.S.N.M.	type 61318	27 miles W. of Indian Oasis, Pima Co., Ariz.	Male	23-21-23-21-19	231	52	7	9	1-2	2-3	1060	.127	37
U. of C.	1836	Colorado River, 10 mi. below Cibola, Ariz.	Male	23-21-19	231	57	7	9	1-2	2-4 2-3	854	.132	42
U. of C.	1837	Colorado River at Pilot Knob, Calif.	Male	23-21-19	225	55	7	9 10	1-2	2-3	900	.131	38
U. of C.	1838	Colorado River, 5 mi. N. E. of Ft. Yuma, Calif.	Female	23-21-19	222	44	7	9	1-2	2-3	1019	.093	29
U. of A.		Tucson, Ariz.	Male	23-21-19	213	47	7	? 10	1-2	2-3	345	.122	36
U. of A.		Yuma, Ariz.	Male	23-21-20	220	50	7	9	1-2	2-3	....	....	29
U. of M.	52252	Tucson, Ariz.	Female	23-21-19	230	47	7	9	1-2	2-3	1172	.121	33
A. N. S.	3574	Ft. Yuma, Calif.	Female	23-21-19	240	51	7	10 9	1-2	3-3	912	.121	35
S. U.	1710	Ft. Lowell, Ariz.	Male	23-21-19	219	49	7	9	1-2	2-3	1106	.128	37
S. U.	4004	Ft. Grant, Graham Co., Ariz.	Female	23-21-19	216	46	7	9	1-2	2-4 2-3	391	.128	35

and adults of *boylii;* and (3) that the basal shading of the white scales, which has resulted in the confusion of the southern Arizona specimens with those from the Cape Region, may well have been derived by *conjuncta* directly from *boylii,* since the latter shows this character sporadically throughout its range.

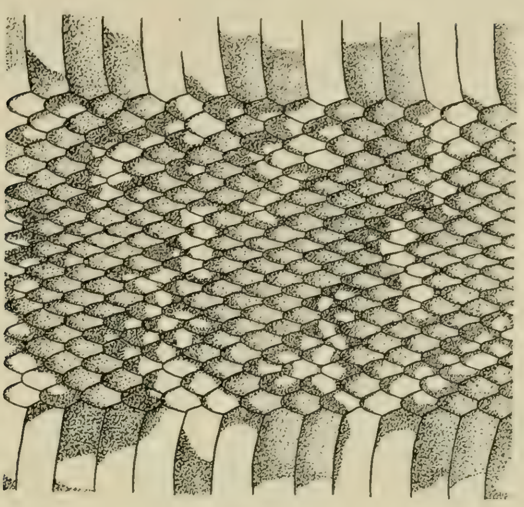

Figure 1

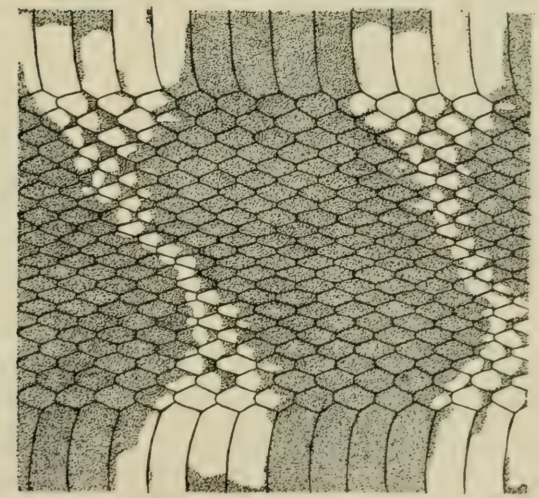

Figure 2

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OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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ON SOME HEMIPTERA FROM WESTERN CANADA

BY H. M. PARSHLEY

Investigation of the origin and present distribution of the hemipterous fauna of northern America has been greatly impeded by the meagreness of collections from the Northwest, for a knowledge of the species occurring in this region is of vital importance in connection with the inviting hypothesis of migration hither from northeastern Asia. A step toward filling this need is made in the present paper, which is based on my study of a considerable collection of Heteroptera from Alberta and British Columbia, and some light is thrown on the general questions involved, although the list of species falls far short of completeness.

The collections have come to my hands through the good offices of my friend John D. Tothill, of the Entomological Laboratory at Fredericton, N. B., who in his travels through the Dominion has not omitted to start in my direction such hemipterous materials as he meets with in nature or in cabinets; and through the kindness of Frederick M. Gaige, of the

Museum of Zoology of the University of Michigan, who has sent me for study an interesting lot from Alberta, collected by Mrs. J. A. Miller, of Edmonton. I am indebted to Mr. W. Downes, of Victoria, and to Mr. M. H. Ruhmann, of Vernon, B. C., for their kindness in sending extensive materials, most of which they themselves have collected. Mr. Downes' collection is especially valuable for the careful and copious notes accompanying it, providing important ethological data for many species concerning which nothing of the kind has hitherto been published. Special acknowledgement is due my colleagues in Hemipterology, Barber, Knight, and Van Duzee, for valued advice in the determination of species on which I felt unable to pass with certainty.

Most of the localities mentioned in the succeeding list will be found on ordinary maps, but some special information regarding them, communicated by Mr. Downes and Mr. Ruhmann, may be of interest. All of the localities on Vancouver Island (indicated 'V. I.' in the list) lie in the southern part. Saanich District (Dist.) is the term applied to the whole peninsula extending north from Victoria and bounded on the west by Saanich Inlet. Royal Oak, not to be found on some maps, is on the peninsula, about four miles north of Victoria; here is located a field laboratory of the Department of Agriculture. Mr. Downes states of Saanich District, "The same faunal and climatic conditions obtain throughout" (*in litt.*). Savary Island lies to the north of Texada Island, in the Gulf of Georgia. Sea Island is across the Straits of Georgia, somewhat south of the city of Vancouver. Most of the localities on the mainland, Vernon, Lillooet, Kelowna, etc., are in the southern part of Yale-Cariboo District, in the region known as the "upper country," of which Downes writes, "The elevation is about 1100 to 1500 feet above sea level, and the climate is very dry in summer and cold in winter. Much of the country consists of open range hills, and on the levels a good deal of fruit farming is carried on with the aid of irrigation." Anderson Lake and Mt. McLean are near Lillooet. All the Alberta material is from Edmonton, in the south central part of the Province.

In the study of our northern fauna species of holarctic distribution require especial attention because the facts of their present occurrence may well furnish reliable clews to movements now lost in the obscurity of the past. In connection with the list of species common to New England and the Palaearctic region, given in a former paper[1], I called attention to the large proportion of holarctic forms occurring in New England, as compared with other regions of the continent, and remarked as follows concerning the bearing of this observation on Horváth's[2] view that such species have migrated hither from eastern Asia, "The latter opinion seems hardly in accord with the apparent massing of the species on the eastern side of the continent, ... but . . . possibly the range [of these species] may be found . . . . to extend westward when our knowledge of the fauna of British America is more nearly complete." In the collections now under consideration there are represented 19 species found also in the Palaearctic region, all of which find place in the New England-Palaearctic list, except *Aradus cinnamomeus* which occurs on Long Island, N. Y.; together with 2 others, *Mecomma gilvipes* and *Ischnorrhynchus franciscanus,* so closely related to the palaearctic *M. ambulans* and *I. resedae* that very possibly they are in reality subspecies[3], differentiated since the disappearance of some of the early conditions favoring migration. These facts lend new support to the hypothesis of palaearctic origin and eastward spread, and we may now predict with some degree of confidence that these species will be found in Alaska and throughout the breadth of Canada. There is room for doubt, however, regarding one of the species of the subjoined list, *Pithanus maerkelii,* the occurrence of which in North America was unsuspected until 1915 when Olsen[4] reported its discovery on Long Island, N. Y. In 1916 I found it in material from Maine and Nova Scotia[5], and now from southern Vancouver Island we again meet with numerous examples identical with those found in the east. Present knowledge of this form does not preclude the opinion that it has been introduced by commerce and is in process of establishment near sea ports, but, on the other hand, it may be in fact a holarctic species, and the matter will be decided only when further collections from the interior are available for study. The following palaearctic species appear in the collections under consideration:—

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[1] Occas. Papers, 7, Boston Soc. Nat. Hist., Fauna N. E. 14, Hem. Het., 1917, pp. 7-9.

[2] Rels. entre faunes hém. Eur. et Am., Ann. Mus. Hungarici, Vol. 6, 1908, p. 7.

[3] This possibility regarding *M. gilvipes* is suggested by Van Duzee, Rept. Hem. Giffard, Proc. Cal. Acad. Sci., (4), Vol. 7, 1917, p. 276. Concerning *I. franciscanus* see page 15 of the present paper.

Corizus crassicornis
Aradus lugubris
A. cinnamomeus
Nysius thymi
N. ericae
Sphragisticus nebulosus
Scolopostethus thomsoni
Nabis ferus
Miris dolabratus
Stenodema trispinosum
Pithanus maerkelii
Stenotus binotatus

Calocoris norvegicus
Poeciloscytus unifasciatus
Capsus ater
Lygus pratensis
L. campestris
Campylomma verbasci
Limnoporus rufoscutellatus

? *Ischnorrhynchus resedae*
? subsp. *franciscanus*
? *Mecomma ambulans*
? subsp. *gilvipes*

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[4] Capsid New to our Fauna, Bull. Brooklyn Ent. Soc., Vol. 10, 1915.

[5] New and Noteworthy Hem. N. E., Ent. News, Vol. 27, 1916, pp. 104-105.

In subsequent pages I have made some further attempts at the discrimination of forms of less than specific value which may intergrade to some degree but still obtrude themselves constantly on the observer as entities usually distinctive in appearance[6]. Such forms in certain cases may owe their peculiarities to the action of special influences during individual development, but this explanation, in my opinion, will not usually suffice. When certain distinct varieties of a given species recur again and again in material from widely separated regions of diverse environmental nature, it would seem sufficiently clear that some factor of genetic or perhaps evolutionary significance is involved, since under such conditions the chance of exact duplication of ontogenetic environment is negligible. Even if it were shown that gross similarity in environing influences, such as a season relatively hot, cold, wet, or dry, could result in a preponderating number of individuals belonging to a certain variety, we would still feel impelled to seek some genetic factor which such conditions might call into activity, in order to account for the detailed nature and general uniformity of the adult varietal characters thus produced. The taxonomist fails in his duty if he avoids the responsibility of discriminating and naming these forms, since in this way only may definite data on distribution and seasons be made known for each, and the student of experimental genetics should not neglect them, since in these forms of Hemiptera he has definite variations produced under natural conditions, and he is therefore free from the justifiable suspicion that laboratory conditions—domestication, so to speak—may have had some untoward influence in the matter. At least he will be able to collect in the field specimens to serve as checks in the consideration of the product of his breeding cages, an advantage which cannot be claimed for most of the conventional materials of such research. Many species of Hemiptera exhibit such naturally occurring varieties, e. g., *Lygaeus kalmii, Stiretrus anchorago, Perillus exaptus,* etc., and some are well adapted for rearing in confinement, wherefore I would suggest that they present a promising field for the student having inclination and facilities for protracted experimental breeding. It should be emphasized, however, that much can be done by the study of extensive series of these varieties collected and preserved with our newly developed care for minuteness in recording data, as is strikingly illustrated in Bateson's "Problems of Genetics," a work full of suggestion for taxonomist and genetic experimentalist alike.

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[6] Cf. my Hem. Notes, Psyche, Vol. 25, 1918, pp. 64-65.

In his Catalogue of the North American Hemiptera, Van Duzee records 87 species of Heteroptera from Alberta and British Columbia, a large majority of these records referring to Vancouver Island. The present report enumerates 144 species from these Provinces, of which 96 are recorded for the first time. The figures given in the following table emphasize the fragmentary nature of our present knowledge of distribution and suggest opportunities open to those who are so situated that they can make carefully annotated collections in the many regions of the continent not yet fully explored entomologically.

Summary of Numerical Data

Species Recorded in	Alberta and British Columbia	Alberta	British Columbia	B. C. excluding Vancouver Island	North America
Van Duzee's Catalogue	87	1	86	comparatively few	1629
Present paper	144	14	137	89	....
Both V. D. Cat. and present paper. Corroborations	48	1	47	13	....
Present paper only. New records	96	13	90	76	....
New England list	419				
Both N. E. and present lists	78	Probably transcontinental in large part.			

Collectors: E. M. Anderson, W. Downes, Mrs. J. A. Miller, M. H. Ruhmann, R. S. Sherman, J. D. Tothill, R. C. Treherne, R. C. Woodward.

LIST OF SPECIES

Family SCUTELLERIDAE

Homaemus aeneifrons (Say).

ALB.—Edmonton, June 15, Aug. 29, 1912 (J. A. M.).

B. C.—Saanich Dist., V. I., Oct. 8, 1917 (W.D.), from willow.

Homaemus bijugis Uhler.

B. C.—Royal Oak, V. I., Oct. 9, 1917 (W. D.), from willow; Vernon, Sept. 26, 1918 (W.D.).

Eurygaster alternatus (Say).

B. C.—Royal Oak, V. I., June 30, 1917 (W. D.); Savary Id., July 10, 1917 (R. S. S.); Victoria, V. I., April 19, 1918 (W. D.); Suswap Falls, June 18, 1916 (E. M. A.).

Family CYDNIDAE

Thyreocoris anthracinus (Uhler).

ALB.—Edmonton, Aug. 10, 1912 (J. A. M.).

Thyreocoris pulicarius (Germar).

B. C.—Vernon, April 17, 1915 (M. H. R.)

Sehirus cinctus (Palisot de Beauvois).

B. C.—Vernon (M. H. R.).

Family PENTATOMIDAE

Brochymena affinis Van Duzee.

B. C.—Vernon, March 23, 1916, May 5, 1915 (M. H. R.).

Peribalus abbreviatus (Uhler).

B. C.—Lillooet, June 28, 1917 (M. H. R.); Vernon, May 5, 1915 (M. H. R.).

Peribalus limbolarius Stål.

B. C.—Royal Oak, V. I., Sept. 6, 1918 (W. D.).

Chlorochroa uhleri Stål.

B. C.—Mt. McLean, June 24, 1917 (M. H. R.); Saanich Dist., V. I., Aug. 8, 1917, nymphs (W. D.), Oct. 27, 1917 (W. D.).

Van Duzee now considers that the eastern *persimilis* Horváth cannot be distinguished from *uhleri*[7], but the British Columbia examples show some of the characters ascribed to *uhleri* by Van Duzee when he considered the species distinct[8]. In the males the genital segment is distinctly shorter ventrally than in eastern specimens, but the form of body is variable in both series and it is impossible to distinguish the females, as far as I can see. Possibly we are dealing with true subspecies (races), and it will be of interest to ascertain the condition of specimens from intervening regions.

Chlorochroa ligata (Say).

B. C.—Vernon, 1908 (M. H. R.).

Chlorochroa sayi Stål.

B. C.—Vernon, Aug. 28, 1917 (M. H. R.).

Carpocoris remotus Horváth.

B. C.—Lillooet, Aug. 3, 1916 (A. W. A. P.); Okanagan Landing, June 21, 1916 (E. M. A.); Vernon, Aug. 10, 1915 (M. H. R.).

Euschistus euschistoides (Vollenhoven).

B. C.—Lillooet, July 23, 1916 (A. W. A. P.).

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[7] See Van Duzee's Check List, 1916, and Catalogue, 1918.

[8] List Pent., Trans. Am. Ent. Soc., Vol. 30, 1904, p. 39.

Euschistus conspersus Uhler.

B. C.—Saanich Dist., V. I., Aug. 18, Oct. 8, 1917 (W. D.); Savary Id., July 10, 1917 (R. S. S.); Vernon, Apr. 18, June 10, 1915 (M. H. R.).

Euschistus variolarius (Palisot de Beauvois).

B. C.—Vernon, June 8, 1916 (M. H. R.).

Aelia americana Dallas.

ALB.—Edmonton, July 1, 1912 (J. A. M.).

Neottiglossa undata (Say).

B. C.—Saanich Dist., V. I., Aug. 3, 1918, Oct. 8, 1917 (W. D.).

Cosmopepla bimaculata (Thomas).

B. C.—Prospect Lake (Saanich Dist.), V. I., Sept. 18, 1917 (W. D.); Vernon, Apr. 3, 1915, July 25. 1917 (M. H. R.).

Cosmopepla conspicillaris (Dallas).

B. C.—Saanich Dist., V. I., May 11, June 6, 1918 (W. D.).

Eysarcoris intergressus Uhler.

B. C.—Saanich Dist., V. I., June 5, 1918, June 30, 1917 (W. D.); Mt. McLean, June 24, 1917 (M. H. R.); Vernon, July 6, 1917 (M. H. R.).

Thyanta custator (Fabricius).

B. C.—Saanich Dist., V. I., Aug. 18, Oct. 8, 1917 (W. D.), on willow.

Banasa dimidiata (Say).

B. C.—Saanich Dist., V. I., June 5, 1918 (W.D.); Vernon, (M. H. R.).

The Saanich specimens were taken on flowers of *Lonicera involucrata* (Richards) Banks and *Chamaenerion* (or *Epilobium*) *angustifolium* (Linné).

Banasa sordida (Uhler).

B. C.—Savary Id., Apr. 9, 1917, July 2, 1918 (R. S. S.).

Meadorus lateralis (Say).

B. C.—Saanich Dist., V. I., Sept. 14, 1918 (W. D.); Vernon, Apr. 28, 1915 (M. H. R.).

Elasmostethus cruciatus (Say).

B. C.—Vancouver, Sept. 16, 1917.

Elasmostethus cooleyi (Van Duzee).

B. C.—Vernon, Apr. 28, 1915 (M. H. R.). Determined by Van Duzee.

Perillus bioculatus var. *claudа* (Say).

B. C.—Okanagan Landing, Aug. 26, 1916 (E. M. A.).

Perillus exaptus (Say).

Alb.—Edmonton, July 17, 1912 (J. A. M.).

B. C.—Cowichan, V. I., Aug. 24, 1918 (W. D.).

Two of the varieties described by Van Duzee[9] are represented: var. *c*, but with lateral pronotal margins red; and var. *d*. These varieties should be named by some student having adequate material, whatever their origin and genetic nature.

Apateticus bracteatus (Fitch).

Alb.—Edmonton, June 15, July 15, 1912 (J. A. M.).

With nymphs (July and August), probably of this species.

Apateticus crocatus (Uhler).

B. C.—Saanich Dist., V. I., Aug. 29, Oct. 10, 1917 (W. D.)

This species has a peculiar habitus, difficult to describe, and the genital pieces differ in form from those of *bracteatus*. The male genital segment in *crocatus* is narrower and its lateral margins are more evenly curved, less sinuate or irregular. In the female sternite 10 is rather distinctly transverse, with its lateral margins less cut into by the projection of parasternite 9 on each side than in *bracteatus*, where sternite 10 is nearly as long as broad and somewhat hour-glass shaped[10].

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[9] List Pent., *l. c.*, pp. 65-66.

[10] For figure see my Synop. Pent. N. E., Psyche, Vol. 22, pl. 16, fig 8.

Downes reports this species from willow and orchard trees, and it has been found attacking cutworms.

Podisus maculiventris (Say).

B. C.—Saanich Dist., V. I., May 8, 1918 (W. D.).

Podisus modestus (Dallas).

Alb.—Edmonton, June 15, July 15, 1912 (J. A. M.).

B. C.— Saanich Dist., V. I., May 11, 1918 (W. D.); Victoria, V. I., July 31, 1918 (W. D.); Vernon, June 8, 1916 (M. H. R.).

Family COREIDAE

Leptoglossus occidentalis Heidemann.

B. C.—Agassiz, Aug. 28, 1914 (W. D.); Duncans, Aug. 25, 1917 (W. D.).

Taken by Downes on Douglas fir, *Pseudotsuga taxifolia* (Lambert) Britton.

Coriomeris humilis (Uhler).

B. C.—Vernon, May 5, 1915 (M. H. R.).

Family ALYDIDAE

Megalotomus quinquespinosus (Say).

B. C.—Savary Id., Aug. 9, 1915 (R. S. S.).

Alydus pluto Uhler.

B. C.—Royal Oak, V. I., Oct. 10, 1917 (W.D.); Victoria, V. I., Sept. 1, 1917 (W. D.); Vernon, Apr. 12, 1915 (M. H. R.).

The characters of this species are adequately described for the first time by Fracker in a recent paper[11].

Alydus eurinus (Say).

B. C.—Vernon, Apr. 12, 1915, July 1, 1917 (M. H. R.).

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[11] Alydinae of U. S., Ann. Ent. Soc. Am., Vol. 11, 1918, pp. 255-282.

Tollius curtulus Stål.

B. C.—Savary Id., July 2, 1915 (R. S. S.); Vernon, July 19, 28, 1918 (R. C. W.).

Family CORIZIDAE

Harmostes reflexulus (Say).

B. C.—Mt. McLean, June 21, 1917 (M. H. R.); Saanich Dist., V. I., June 18, Sept. 4, 1917 (W. D.); Vernon, June 10, 1918, Aug. 10, 1917 (M. H. R.).

Harmostes croceus Gibson.

Ent. News, Vol. 28, 1917, p. 445.

B. C.—Royal Oak, V. I., June 18, 1917 (W.D.).

Corizus crassicornis (Linné).

B. C.—Royal Oak, V. I., June 15, Oct. 9, 1917 (W. D.); Vernon, June 24, 1917 (R. C. T.), Aug. 12, 1917 (M. H. R.).

Corizus bohemani Signoret.

B. C.—Vernon, Aug. 28, 1917 (M. H. R.).

Corizus indentatus Hambleton.

B. C.—Royal Oak, V. I., Aug. 14, 1917 (W. D.); Victoria, V. I., Sept. 30, 1917 (W. D.); Vernon, Aug. 28, 1918 (R. C. W.).

Leptocoris trivittatus (Say).

B. C.—Summerland, Sept. 28, 1918 (W. D.); Vernon (M. H. R.).

Family ARADIDAE

Aradus behrensi Bergroth.

B. C.—Yale, May 26, 1918 (W. D.).

Aradus debilis Uhler.

B. C.—Saanich Dist., V. I., Aug. 6, 1918 (W. D.); Mt. McLean, June 19, 1917 (M. H. R.).

Downes writes concerning his specimen: "The nymphs feed on a yellow fungus of puff-ball type, growing on the bark of dead fir stumps. Adult was raised from last stage nymph taken in May. This nymph was kept alive in a vial without food for three months, but was supplied with a piece of rotten wood and slight moisture, and moulted to adult on August 6th." This note is of especial interest since there seem to be on record no definite statements concerning the food of *Aradus*. I would suggest that in all probability the nymph found suitable fungous food in the rotten wood supplied. With my friend de la Torre Bueno I very recently made an observation bearing on the matter. In this case we watched a captive adult of *Aradus quadrilineatus* with its rostrum inserted in the spongy and fungus filled substance of a piece of damp rotten bark, undoubtedly drawing up the juices present.

Aradus inornatus Uhler.

B. C.—Vernon, May 31, 1917 (M. H. R.).

Aradus funestus Bergroth.

B. C.—Vernon (M. H. R.).

Aradus lugubris Fallén.

ALB.—Edmonton, July 26, 1912 (J. A. M.).

Aradus cinnamomeus Panzer.

B. C.—Kelowna, May 17, 1917 (M. H. R.); Vernon, Apr. 12, 1915 (M. H. R.).

Aradus insoletus Van Duzee.

B. C.—Vernon, Apr. 12, 1915 (M. H. R.).

Family NEIDIDAE

Neides muticus (Say).

B. C.—Duncans, V. I., Aug. 25, 1917 (W. D.); Kelowna, May 17, 1917 (M. H. R.); Saanich Dist., V. I., Apr. 19, 1918 (W. D.); Vernon, June 16, 1917, (R. T. C.), July 26, 1917 (M. H. R.).

Family LYGAEIDAE

Lygaeus kalmii Stål, subsp. *kalmii* Stål, mihi.

B. C.—Revelstoke, Oct. 10, 1917 (M. H. R.); Vernon, June 10, 1918 (R. C. T.).

In describing *kalmii*, Stål[12] distinguished three color varieties, which he designated *a*, *b*, and *c*. In spite of Stål's clear description *kalmii* and *turcicus* Fabricius were much confused until Montandon published a paper[13] in which he reëmphasized the distinguishing characters of the two species, redescribed (without naming) the three varieties of *kalmii* Stål, and added another which he called *melanodermus*.

After an examination of extensive materials, kindly sent by H. G. Barber, E. H. Gibson, and others, and some discussion of the matter in correspondence, especially with Barber, I am led to the conclusion that there are two distinct geographical races of *kalmii*, which may be discriminated as follows:

Subsp. *kalmii* Stål (typ.) Western race. Membrane of hemielytra with two discal white spots and with a broad white margin; red band between corium and membrane strongly narrowed at middle; general form of body usually rather narrow, sides of body more nearly parallel. Texas, Arizona, Kansas and westward.

Subsp. **angustomarginatus** subsp. nov. Eastern race. Membrane usually without discal spots, rarely with small ones, white margin extremely narrow or rarely absent; red band between corium and membrane broader, almost or quite as wide as that between corium and clavus; form usually a little broader, the sides more strongly arcuate. Texas, Kansas, Wisconsin, and eastward.

These two subspecies can always be distinguished by a difference of habitus, arising from the characters mentioned and others less readily definable in words, without reference to locality of collection. The varieties *a* and *b* of Stål fall under subsp. *kalmii,* var. *c* under subsp. *angustomarginatus.* These, with var. *melanodermus* Montd. and a number of undescribed varieties, are color forms of more or less doubtful value, to be discussed in another place where further data on the subspecies will be given.

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[12] Enum. Hem., 4, 1874, p. 107.

[13] Lyg. exot., Ann. Soc. Ent. Belgique, Vol 37, 1893, pp. 399-406.

Typical examples of the new subspecies will be placed in the Museum of Zoology of the University of Michigan and in the United States National Museum.

Lygaeus bicrucis Say.

B. C.—Saanich Dist., V. I., Aug. 16, 1917 (W. D.).

Nysius thymi (Wolff).

B. C.—Vernon, Aug. 10, 1917 (M. H. R.)

Barber has kindly verified this determination.

Nysius ericae (Schilling).

B. C.—Saanich Dist., V. I., Aug. 21, Nov. 13, 1917 (W. D.); Vernon, Aug. 10, 1917 (M. H. R.).

Mr. Ruhmann writes that at Vernon this species appeared in great numbers, swarming over the trails and entering houses. For a few days the walls of the houses inside and out were covered with the insects and complaints were made that they bit children, altogether a most unusual occurrence.

Ischnorrhynchus franciscanus (Stål).

B. C.—Saanich Dist., V. I., Apr. 27, 1918, Aug. 18, 1917 (W. D.); Shawnigan, V. I., July 21, 1918 (W. D.); Vernon, Mar. 6, 1915 (M. H. R.).

I feel some doubt regarding the relations between *franciscanus, resedae* (Panzer), and *geminatus* (Say). The specimens recorded here agree with Stål's description and they have been determined by Barber. Horváth's characterization of *resedae*[14], drawn up with American examples before him, happens to fit these specimens pretty well, and before I was acquainted with the description of *franciscanus* I felt inclined to consider these specimens as examples of *resedae,* the first I had seen from America. Moreover they agree fairly well with my European examples of *resedae.* I doubt the occurrence of typical *resedae* in America and Barber writes that he is coming to the same conclusion. Possibly a thorough study of these three forms, with ample material, would show that they are not distinct species.

Cymus luridus Stål.

B. C.—Saanich Dist., V. I., June 5, 1918 (W. D.); Shawnigan, V. I., July 21, 1918 (W. D.).

Blissus leucopterus (Say).

B. C.—Saanich Dist., V. I., Aug. 25, 1918 (W. D.).

Geocoris bullatus var. *bullatus* (Say).

B. C.—Royal Oak, V. I., Sept. 28, 1917 (W. D.)

Geocoris bullatus var. *discopterus* Stål.

B. C.—Gordon Head, V. I., Aug. 2, 1918 (W. D.).

Geocoris atricolor Montandon.

B. C.—Victoria, V.I., July 22, 1918 (W. D.).

Ligyrocoris contractus (Say).

B. C.—Saanich Dist., V. I., July 22, 1918, Sept. 18, 1917 (W. D.).

Pseudocnemodus canadensis (Provancher).

B. C.—Vernon, Aug. 18, 1915 (M. H. R.).

Peritrechus fraternus Uhler.

B. C.—Vernon, Mar. 20, 1915 (M. H. R.).

Peritrechus tristis Van Duzee.

B. C.—Saanich Dist., V. I., Apr. 4, 1918, Oct. 22, 1917 (W. D.); Vernon, Mar. 20, 1915 (M. H. R.).

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[14] Remarques Hem. Am. Nord, Ann. Mus. Nat. Hungarici, Vol. 6, 1908, p. 560.

Malezonotus sodalicius (Uhler).

B. C.—Saanich Dist., V. I., Apr. 30, May 6, 1918 (W. D.).

Reported by Downes as common in strawberry fields.

Malezonotus Barber[15] is a genus recently proposed to accommodate certain species formerly placed in Rhyparochromus Curtis and Trapezonotus Fieber.

Malezonotus angustatus (Van Duzee).

B. C.—Saanich Dist., V. I., Apr. 4, 1918 (W. D.).

Described under Rhyparochromus by Van Duzee.

Sphragisticus nebulosus (Fallén).

B. C.—Vernon, Mar. 20, 1915 (M. H. R.).

Emblethis vicarius Horváth.

B. C.—Saanich Dist., V. I., Aug. 2, Nov. 24, 1917 (W. D.); Sidney, V. I., Sept. 4, 1917, nymph (W. D.).

Eremocoris ferus (Say).

B. C.—Vernon (M. H. R.)

Eremocoris obscurus Van Duzee.

B. C.—Vernon, May 5, 1915 (M. H. R.).

Scolopostethus thomsoni Reuter.

B. C.—Saanich Dist., V. I., Apr. 4, 1918, Oct. 22, 1917 (W. D.); Victoria, V. I., Apr. 18, 1918 (W. D.).

Taken in sweeping willow. The brachypterous form in this species, as in the next, has the lateral margins of the pronotum straight, presenting an appearance rather unlike that of the macropterous, where these margins are concavely arcuate (Barber *in litt.*).

Scolopostethus atlanticus Horvàth.

B. C.—Saanich Dist., V. I., May 3, 1918 (W. D.).

This species is very closely allied to the European *affinis* Schilling, scarcely distinguishable from it, in fact. Possibly we may trace here the steps in evolutionary differentiation, consequent upon the severance of former paths of migration.

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[15] Synop. Keys Lyg., Psyche, Vol. 25, 1918, pp. 71-88.
Concerning Lyg. 2, Jour. N. Y. Ent. Soc., Vol. 26, 1918, p. 54.

Family TINGIDAE

Corythucha distincta Osborn and Drake.

B. C.—Vernon, July 11, 1914 (M. H. R.), Sept. 27, 1918 (W. D.).

Taken on hollyhock by Downes. In fresh specimens, with colors dark and unfaded, the marginal spines are almost entirely lacking, a condition characteristic of the species and not due to accidental causes as Gibson suggests. Thus the status of var. *spinata* Osborn and Drake cannot be considered as settled[16].

Corythucha canadensis sp. nov.

Membranous portions opaque white, some of the areoles hyaline; disc of pronotum brown; posterior lobe of hood largely brown, anterior lobe with narrow lateral brown stripes; paranota with two brown spots, of which the anterior is larger; median carina with a brown spot; lateral carinae and apex of angulate process white. Hemielytra with distinct apical and basal brown bands, the former broad, occupying one-third of the hemielytra and enclosing several hyaline areoles, the latter made up of separate spots on humeri and discal elevations; costal margin with a small brown spot at middle. Antennae, legs, and plates forming rostral groove reddish brown, the last mentioned sometimes darker. Body piceous.

Hood barely twice as high as median carina and slightly longer than the carina, its height a little more than one half the length of carina and equal to one half its own length, its width slightly more than one-third entire width of prothorax; hood sharply constricted, posterior lobe circular in outline as seen from above and a little more than twice as wide as the narrow parallel anterior lobe; hood as seen in profile low, anterior and posterior margins straight, forming a very obtuse angle, the apex rounded. Median carina slightly shorter than hood, slightly arched anteriorly, with two series of areoles at middle, four times as long as high. Lateral carinae moderately developed, with two or three areoles, terminating at a distance from base of hood equal to height of median carina. Costal margins of hemielytra slightly convex; spines of costal and paranotal margins very rudimentary; discal elevations rather small, not reaching middle of hemielytra, with sharp dorsal edge; costal area largely triseriate. Antennae with rather numerous long setae. Length, male 3.48 mm., female 3.57 mm.; width, male 2.00 mm., female 2.08 mm.

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[16] See Gibson, The Genus Corythucha Stal, Trans. Am. Ent. Soc., Vol. 44, 1918, p. 81. Consult this paper for references to literature on the genus.

Holotype female, Vernon, B. C., Sept. 28, 1918 (W. D.), in National Collection at Ottawa; allotype, same data; four paratypes, same data, in collections of Downes, Van Duzee, and the writer.

This species has been taken on willow. It runs to 21 in Gibson's key and resembles *distincta* in general appearance, being distinguished as follows: hood much lower and narrower, lateral carinae smaller and terminating far from base of hood. It is larger than *pergandei* Heidemann, lacks distinct marginal spines, and is of a totally different habitus. *C. contaminata* Gibson is of narrower form, has larger lateral carinae with 5 or 6 distinct areoles, and is provided with marginal spines.

Corythucha padi Drake.

B. C.—Goldstream, V. I., June 2, 1918 (W. D.); Vernon,
Apr. 17, 1915, July 11, 1914 (M. H. R.).

Reported by Downes from "alder and hazel." In the original description Drake describes the costal margin as "concave, sinuate," while Gibson in his redescription makes it "nearly straight." In this series of 15 specimens some variation in this character is to be observed, but all show more or less concavity. Certain specimens also exhibit the paler colors and the medial evanescence of the apical band mentioned by Drake.

Corythucha salicata Gibson.

B. C.—Saanich Dist., V. I., May 8, Sept. 28, 1918 (W. D.);
Vernon, April 23, 1915 (M. H. R.).

Taken by Downes on alder. The markings in this species are even more variable than indicated in the original description, ranging from very distinct to almost obsolete. The apical marking of each hemielytron, when well developed, forms an oblique band situated at some distance from the apex. The reticulation of the hood is also somewhat variable, the areoles of the hood being in some cases rather larger than those of the paranota.

Corythucha marmorata Uhler.

B. C.—Vernon, July 11, 1914 (M. H. R.).

Corythucha marmorata var. **informis** var. nov.

Membranous portions milky white as a rule, many of the areoles hyaline at center; disc of pronotum brown; edges of angulate process and lateral carinae white; hood with a narrow transverse brown band on posterior lobe and two longitudinal stripes on anterior; paranota with a large brownish spot at middle and often a smaller one posteriorly; median carina with a brown spot. Hemielytra with apical, basal, and intermediate transverse brown bands, made up of more or less confluent spots of which there are three in each costal area and one on each discal elevation; the apical band divided transversely, except sometimes at the costal margins, by a row of pale areoles; region anterior to elevations brownish. Antennae, legs, and plates forming rostral groove brownish yellow. Body piceous, the pleurae paler.

Hood usually twice as high as and considerably longer than the median carina, its height about one-half its own length, its width about one-third width of entire prothorax; anterior lobe parallel, about one-half width of posterior; hood as seen in profile rounded above, anterior margin nearly straight; areoles of hood equal in size to those of paranota. Median carina shorter than hood, almost one-half as high as long, arched, with two series of areoles at middle. Lateral carinae slightly developed, mere tabs at anterior corners of angulate process (the sides of which are not elevated posteriorly), containing only two or three scarcely perceptible areoles and terminating far from base of hood. Hemielytra very short, together a little broader than long; costal margins straight, slightly convex, or slightly concave, usually somewhat retro-convergent; marginal spines, including those of paranota, small, numerous, closely set; discal elevations comparatively large, nearly as high as median carina, almost hemispherical, extending posteriorly to or a little beyond middle of hemielytra and anteriorly to inward band of costal area, which is biseriate at middle, triseriate anteriorly and posteriorly. Antennae with very few long setae. Length, male 2.87 mm., female 3.13 mm.; width, male 1.83 mm., female 1.9 mm.

Holotype female, Vernon, B. C., July 11, 1914 (M. H. R.), allotype, Vernon, B. C., Sept. 25, 1918 (W. D.), in the National Collection at Ottawa; paratypes, eight with same data, in Downes', Ruhmann's, and my collections; Colorado, and Truro, Nova Scotia, Aug. 14, 1917, in Drake's collection.

Food plant not recorded. The extreme development of this form is described above. This I considered a distinct and very peculiar species until recently, when I received through the kindness of Professor C. J. Drake a series of specimens containing intermediates which lead indubitably to typical *marmorata,* through atypical forms of the latter common in every collection, and which fully support the idea expressed by Drake (*in litt.*), that *informis* and *marmorata* are not specifically distinct. *Informis* is not a geographical race, since it occurs in districts as widely separated as Nova Scotia, Colorado, and British Columbia, in company with the typical form. The color pattern is essentially alike in all of the specimens examined and is identical with that of typical *marmorata,* the presence of an intermediate hemielytral band and the transverse division of the apical band by a row of pale areoles being characteristic. The intensity of the markings is subject to variation, as usual. The height of the hood, proportions of hemielytra and their discal elevations, and length of marginal spines all vary, and there are before me various stages in the development of all these structural characters, leading to the extreme variety *informis.* In typical *marmorata* the hood is frequently twice as high as the median carina, a point which may cause confusion in the use of Gibson's key.

In explanation of this unusual degree of variability, I would suggest that in the species under consideration we may note the appearance of a distinct tendency toward pterygo-polymorphism, a phenomenon of wide spread occurrence among the Tingidae but not hitherto observed in the genus Corythucha. Specimens of *informis* are at hand which have the hind wings much shorter than the abdomen and the hemielytra reduced as described above, while in typical *marmorata* the wings often extend considerably beyond the abdominal apex and the hemielytra are of course fully developed. But there are certain peculiarities in *informis* which would not be expected to result from mere polymorphism of wings, as it appears in other groups, and hence the form may well be distinguished by a definite name at least until its true nature is more fully understood.

Corythucha hesperia sp. nov.

Membranous portions hyaline, with a general brownish tinge; disc of pronotum brown; dorsal veinlets of hood brown; paranota immaculate or with a faint brownish spot before middle; median carina with a brown spot; lateral carinae and apex of angulate process white. Hemielytra with broad and distinct apical and basal brown bands; without included clear areoles, the extreme apical row of areoles hyaline. Antennae, legs, and plates forming rostral groove light yellow. Body piceous.

Hood more than twice as high as median carina and somewhat longer, its height equal to length of carina and not quite two-thirds its own length, its width three-sevenths width of entire prothorax; hood rather sharply constricted, posterior lobe as long as anterior and twice as wide; hood as seen in profile rounded above, the anterior and posterior margins nearly straight. Median carina shorter than hood, distinctly arched, with two series of areoles at middle, its height nearly one-third its length. Lateral carinae small, scarcely reticulated, terminating far from base of hood. Costal margins of hemielytra nearly straight, the spines rather long, about as far apart as long; discal elevations of moderate size, with sharp dorsal edge; costal area largely triseriate. Antennae with rather numerous long setae. Length, female 3.05 mm.; width, female 1.08 mm.

Holotype female, Vernon, B. C., May 24, 1918 (W.D.), in the National Collection at Ottawa; three paratypes, same data, in Downes' and in my collection.

Labeled by Downes "hazel, alder, birch, choke cherry," the food plant being doubtless one or more of these. This form is closely related to *borealis* Parshley, to which it runs in Gibson's key and from which it is to be distinguished by the following characters: apical band of hemielytra without clear areoles (*borealis* has three almost entirely hyaline); paranotal spot very faint or absent; lateral carinae smaller and terminating farther from base of hood; median carina a little lower; discal elevations less suddenly declivous posteriorly.

Corythucha pura Gibson.

B. C.—Kelowna, May 17, 1917 (M. H. R.).

Taken on wild sunflower. The sixteen specimens of this series agree well with the original description and with a typical example which I owe to Gibson's kindness. The areoles of the hood vary a little in size, but are usually somewhat larger than those of the paranota. The height of the hood is also slightly variable, occasionally reaching twice the height of the median carina. In some examples a faint yellowish tinge is to be detected in the regions occupied in other species by the apical and basal hemielytral bands.

Physatocheila variegata Parshley.

Parshley, Tingidae N. E., Psyche, Vol. 23, 1916, p. 166.
Osborn and Drake, Notes Tingidae, Psyche, Vol. 24, 1917, p. 156.
Van Duzee, Rept. Hem. Giffard, Proc. Cal. Acad. Sci., (4), Vol. 7, 1917, p. 260.

B. C.—Vernon, Apr. 20, 1915 (M. H. R.).

With regard to remarks to be found under the second reference given above, it may be said that Uhler and Heidemann were acquainted with but one of the forms to which, in general, Say's description of *Tingis plexus* (Compl. Writ., Vol. 1, pp. 349-350) might be considered to apply, this form being the one which I have named *variegata,* though the two authors mentioned called it *plexa.* Possibly we might be satisfied with such identification, though the discrepancies are considerable in my opinion, provided no form agreeing better with Say's description were known. But such a form has come to light, and is discussed under the first reference given above as the true *plexus* of Say. It is gratifying to note than in his key to the genus, given under the third reference, Van Duzee agrees with my interpretation of the matter.

Family PHYMATIDAE

Phymata erosa subsp. *fasciata* (Gray).

B. C.—Lillooet, Sept. 2, 1918 (M. H. R.).

Family REDUVIIDAE

Ploiariola hirtipes (Banks).

B. C.—Victoria, V. I., Sept. 8, 1918 (W. D.), in cellar.

Ploiariola canadensis sp. nov.

Color light brown in general, basal segment of rostrum and antenniferous tubercles marked with black, anterior lobe of head yellowish with Y-shaped median dorsal mark, posterior lobe yellowish with median line and posterior margin black, sides of head dark; antennae pale, with numerous rather regularly alternating narrow and broad black rings. Pronotum with lateral carinae and posterior margin white, the disc completely outlined by a dark brown submarginal line which is broader and more irregular anteriorly. Scutellum dark brown, the spine, posterior margin, and two posteriorly converging discal carinae pale. Free margin and spine of postscutellum pale. Front coxae pale, with an incomplete black ring beyond middle; trochanters pale; femora with four black rings of which the basal, medial, and subapical are narrow, the apical broad and not quite reaching apex of femora; tibiae with two black rings in basal half, of which the distal is the broader, apex slightly darkened. Middle and hind legs with numerous narrow black rings, which are evanescent toward the apices of the tibiae. Meso- and metapleurae dark brown with faint longitudinal paler markings. Connexivum and margins of genital pieces pale. Hemielytra pale, mottled with numerous brown spots, which are irregular except a quadrangular series around apical and inner margin of membrane; costal margin with a distinct elongated black spot at extreme apex of corium, in front of which is a linear white area twice as long as the spot, and further toward apex is a large irregular white area outside the large basal cell of membrane.

Gula finely pubescent; part of head anterior to interocular groove as seen from the side slightly higher and about as long as part behind the groove. Antennae (female) with fine sparse decumbent pubescence, the hairs somewhat longer than the thickness of the segment; first antennal segment twice as long as head and thorax to apex of scutellum together, second a little shorter than the first, third and fourth missing. Head three-fourths length of pronotum, a little longer than broad including eyes; anterior lobe seven-tenths width of posterior and slightly shorter, including antenniferous tubercles; posterior lobe nearly orbicular, with a median longitudinal depression. Pronotum almost rectangular, slightly widened posteriorly, the anterior lobe a little less than one-half length of posterior; median basal tubercle very slightly elevated, concolorous with disc; lateral margins nearly straight, sinuate posteriorly, lateral angles prominent, rounded, continued in short lobes covering base of hemielytra laterally. Scutellum transverse, with a blunt tubercle extending posteriorly (scarcely a spine); postscutellum almost twice length of scutellum, with a long, almost erect spine. Hemielytra extending to apex of abdomen. Front coxae two-fifths longer than head; femora slightly more than twice length of coxae, densely pilose beneath, with a series of very minute spinules of which those in basal half are larger; tibiae about three-fourths length of femora, incrassate at apex. Hind femora two-fifths longer than middle femora, extending considerably beyond apex of abdomen. The lateral pale appendages situated dorsally at base of female genitalia short, cylindrical, obliquely truncate at apex. Length, female 7 mm.

Holotype female, Victoria, V. I., B. C., July 26, 1918 (W. D.), in the National Collection at Ottawa.

This species is much larger than the other American forms, except *hirtipes* Banks, from which it is to be distinguished by its much darker coloration, and the very short pubescence of the middle and hind legs. It is especially characterized by the extremely short scutellar spine, slightly developed basal tubercle of pronotum, and distinct markings of head and thorax.

Rhynocoris ventralis (Say).

B. C.—Vernon, May 5, 1915 (M. H. R.).

This specimen belongs to the typical variety, having the corium red, the anterior lobe of the pronotum black, and the connexivum conspicuously spotted with black. The legs, however, are dark reddish, showing a tendency toward var. *annulipes* Van Duzee. After a study of more ample material, I now agree with Van Duzee's view that *americanus* Bergroth is a variety of *ventralis,* and not a distinct species as I formerly maintained[17].

Sinea diadema (Fabricius).

B. C.—Vernon, Aug. 28, 1918 (R. C. W.); Lillooet, Sept. 11, 1916 (A. W. A. P.).

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[17] Review Van D. Check List, Psyche, Vol. 23, 1916, pp. 128-129.

Family NABIDAE

Pagasa fusca (Stein).

B. C.—Royal Oak, V. I., Nov. 13, 1917 (W. D.).

Nabis subcoleoptratus Kirby.

Alb.—Edmonton, July 26, 1912 (J. A. M.).

Nabis ferus (Linné).

B. C.—Lillooet (A. W. A. P); Vernon, Mar. 6, 1915 (M. H. R.).

?*Nabis ferus* var. *punctatus* Costa.

B. C.—Saanich Dist., V. I., June 30, Nov. 13, 1917 (W. D.); Vernon, Mar. 6, 1915 (M. H. R.). Determined with some doubt by Barber.

Nabis roseipennis Reuter.

Alb.—Edmonton, June 15, 1912 (J. A. M.).

B. C.—Vernon, May 5, 1915 (M. H. R.).

Nabis rufusculus Reuter.

B. C.—Saanich Dist., V. I., Oct. 8, 1917 (W. D.); Vernon, Mar. 6, 1915 (M. H. R.).

Family ANTHOCORIDAE

Anthocoris antevolens White.

B. C.—Saanich Dist., V. I., Apr. 4, 1918, Sept. 29, 1917 (W. D.); Long Lake, Aug. 10, 1917 (M. H. R.); Vernon, Apr. 20, 1915 (M. H. R.).

Taken by Downes on willow.

Triphleps insidiosus var. *tristicolor* White.

B. C.—Saanich Dist., V. I., Aug. 18, Sept. 29, 1917 (W. D.); Vernon, July 10, 1917 (M. H. R.).

T. tristicolor is usually considered to be specifically distinct from *insidiosus,* but there are no grounds for maintaining its separation, since it differs only in having the clavus black while this part is largely pale in *insidiosus*. *Tristicolor* cannot be considered even a geographical form since I have recently detected it from several localities in New England, where it occurs in company with the typical variety. These eastern examples agree with specimens from the west and Van Duzee concurs in their identification as *tristicolor*. In his monograph of the family Reuter says of *insidious*, "A *Tr. tristicolore* B.-Wh. vix nisi colore hemielytrorum divergens," but treats them as separate species. His var. β of *tristicolor*, "Clavo margine exteriore macula albido-testacea ante apicem" may be considered an intermediate leading toward the condition characteristic of the typical variety.

Family MIRIDAE

Miris dolabratus (Linné).

B. C.—Lillooet (A. W. A. P.).

Stenodema trispinosum Reuter.

B. C.—Saanich Dist., V. I., May 11, 1918, Aug. 14, 1917 (W. D.); Vernon, Apr. 17, 1915 (M. H. R.).

Stenodema vicinum (Provancher).

B. C.—Saanich Dist., V. I., May 8, 1918, Aug. 18, 1917 (W. D.); Vernon, Apr. 28, 1915, Aug. 10, 1917 (M. H. R.).

Megaloceraea debilis Uhler.

B. C.—Vernon, June 16, 1917 (R. C. T.).

Trigonotylus sp.

B. C.—Shawnigan, V. I., July 21, 1918 (W. D.).

Platytylellus bivittis (Stål).

B. C.—Saanich Dist., V. I., July 24, Aug. 14, 1917 (W. D.). Taken on willow.

Pithanus maerkelii (Herrich-Schaeffer).

B. C.—Saanich Dist., V. I., June 18, 1918, July 24, 1917 (W. D.).

Phytocoris lasiomerus Reuter.

B. C.—Victoria, V. I., July 31, 1918 (W. D.).

Phytocoris interspersus Uhler.

B. C.—Saanich Dist., V. I., Sept. 8, 1917 (W. D.); Victoria, V. I., July 31, 1918 (W. D.).

Phytocoris eximius Reuter.

B. C.—Saanich Dist., V. I., Aug. 18, 1917 (W. D.); Victoria, V. I., July 31, 1918 (W. D.).

Adelphocoris superbus (Uhler).

Alb.—Edmonton, July 1, Aug. 29, 1912 (J. A. M.).

B. C.—Saanich Dist., V. I., Aug. 3, 1918 (W. D.); Vernon, July 25, 1917 (M. H. R.).

Stenotus binotatus (Fabricius).

B. C.—Saanich Dist., V. I., June 30, 1917 (W. D.).

Irbisia brachycerus var. *solani* Heidemann.

B. C.—Vernon, May 24, 1918 (W. D.).

Thyrillus pacificus (Uhler).

B. C.—Vernon, June 16, 1917 (R. C. T.).

Calocoris norvegicus (Gmelin).

B. C.—Royal Oak, V. I., July 24, 1917 (W. D.); Lillooet, July 23, 1917, 6000 ft. (R. C. T.).

Poeciloscytus unifasciatus (Fabricius).

B. C.—Lillooet (A. W. A. P.).

Capsus ater (Linné).

Alb.—Edmonton, June 15, Aug. 14, 1912 (J. A. M.).

Lygus pratensis var. *oblineatus* (Say).

Alb.—Edmonton, June 15, 1912 (J. A. M.).

B. C.—Saanich Dist., V. I., July 31, Sept. 4, 1917 (W. D.); Vernon, Mar. 20, 1915, Aug. 19, 1917 (M. H. R.).

Lygus atriflavus Knight.

Bull. Cornell Agr. Exp. Sta., No. 391, 1917, p. 572.

B. C.—Royal Oak, V. I., July 24, Aug. 15, 1917 (W. D.); Vernon, July 10, 25, 1917 (M. H. R.).

Lygus elisus Van Duzee.

B. C.—Saanich Dist., V. I., June 30, Sept. 8, 1917 (W. D.); Lillooet (A. W. A. P.); Vernon, July 10, 1917 (M. H. R.).

Lygus elisus var. *hesperus* Knight.

Op. cit., p. 575.

B. C.—Royal Oak, V. I., Aug. 13, 1917 (W. D.).

Lygus nubilosus Knight.

Op. cit., p. 585.

B. C.—Royal Oak, V. I., Aug. 18, 1917 (W. D.).

Lygus campestris (Linné).

B. C.—Vernon, Aug. 1, 1917 (M. H. R.).

Lygus communis Knight.

Can. Ent., Vol. 48, 1916, p. 346.

B. C.—Saanich Dist., V. I., July 8, 1918 (W. D.).

Camptobrochis validus Reuter.

B. C.—Saanich Dist., V. I., Apr. 19, 1918 (W. D.); Victoria, V. I., July 14, 1918 (W. D.); Vernon, Mar. 20, 1915 (M. H. R.).

Orectoderus spp.

B. C.—Saanich Dist., V. I., July 3, 1918 (W. D.).

Several myrmecoid females taken on salmon berry, undetermined in the absence of males.

Dicyphus agilis (Uhler).

B. C.—Saanich Dist., V. I., June 22, Aug. 3, 1918 (W. D.).

Dicyphus vestitus Uhler.

B. C.—Saanich Dist., V. I., Apr. 30, Sept. 14, 1918 (W. D.).

Strongylocoris stygicus (Say).

ALB.—Edmonton, Aug. 10, 1912 (J. A. M.).

Ceratocapsus modestus (Uhler).

B. C.—Royal Oak, V. I., Sept. 28, 1917 (W. D.), on willow.

Lopidea aculeata Van Duzee.

Rept. Hem. Giffard, Proc. Cal. Acad. Sci., (4), Vol. 7, 1917, p. 271.

B. C.—Saanich Dist., V. I., Sidney, Sept. 4, 1917 (W. D.);
Sea Island, Aug. 11, 1916 (R. C. T.).

Taken by Downes on goldenrod and reported as injurious to potatoes.

Hadronema militaris Uhler.

ALB.—Edmonton, July 1, 26, 1912 (J. A. M.).
B. C.—Vernon, June 14, 1917 (R. C. T.).

Paraproba nigrinervis Van Duzee.

Op. cit., p. 274.

B. C.—Victoria, V. I., July 14, 1917 (W. D.).

Downes reports that this species was common in his garden, where one was seen feeding on a dead fly.

Diaphnidia debilis Uhler.

B. C.—Royal Oak, V. I., Aug. 18, Sept. 29, 1917 (W. D.);
Victoria, V. I., July 14, 1918 (W. D.).

Diaphnidia provancheri Burque.

B. C.—Victoria, V. I., July 31, 1918 (W. D.).

Orthotylus insignis Van Duzee.

B. C.—Vernon, June 8, 1918 (R. C. T.).

Orthotylus tibialis Van Duzee.

B. C.—Mt. McLean, June 21, 1917 (M. H. R.).

This and the preceding species determined by Van Duzee.

Orthotylus pacificus Van Duzee, sp. nov.

"Closely allied to *dorsalis* but larger with longer antennae; black, marked with fulvotestaceous about as in *dorsalis,* the cuneus entirely pale, dextral male clasper deeply notched; length to tip of membrane 6 mm.

"Vertex moderately convex, transversely depressed before the broad convex basal carina, this depression produced forward a little on the median line. First antennal segment as long as posterior lobe of pronotum; second as long as from the base of pronotum to the apex of clavus; third about one-half the length of the second; fourth one-half the third and subequal to the first. Length of pronotum a little more than one-half its basal width; callosities prominent, broad oval, well defined posteriorly by an impressed line; sides slightly arcuated with the anterior angles well rounded; hind margin truncate. Elytra long, parallel, the costa almost rectilinear; abdomen attaining basal third of cuneus. Whole upper surface sparsely clothed with a short pale appressed pubescence. Rostrum attaining middle of intermediate coxae. Dextral male clasper almost straight along its ventral margin, produced in a smooth acuminate point at apex; dorsally produced in two serrated squarish lobes, the basal longer and a little narrower; sinistral clasper as long as the dextral, almost linear and a little sinuous, its base dorsally with a long slender parallel appendage which is bent into a curved hook at apex and attains the apical fourth of the clasper.

"Color fuscous or black marked with fulvotestaceous; above mostly black; margin of vertex next the eyes, anterior and lateral margins of pronotum, a broad median vitta from behind the callosities to apex of scutellum, and slender scutellar and commisural margins of the clavus, pale. Corium and cuneus pale, the former with a large fuscous spot on its inner angle, which begins at the basal third and follows the radial nervure to its apical one-fourth where it forms a squarish projection extending half way to the costa; cuneus deeper yellow, immaculate. Membrane smoky, with a hyaline spot at outer angle beyond the areole followed by a deeper fuscous ray; veins yellowish at apex. Beneath pale with a black lateral vitta which may cover most of the venter; the male genital segment pale. Legs soiled yellowish, paler on the base of the femora, the tip of the rostrum and the tarsi infuscated. Antennae entirely black.

"Described from two males and one female taken at Victoria, V. I., B. C., July 14, 1918, on willow, by W. Downes.

"Holotype male in National Collection at Ottawa; allotype in collection of H. M. Parshley; paratype in collection of E. P. Van Duzee."

Since Van Duzee has recently published a review of Orthotylus I submitted the specimens of this species to him for study, and he has kindly sent the description quoted above for inclusion in the present paper.

Orthotylus formosus Van Duzee.

B. C.—Saanich Dist., V. I., July 8, 1918 (W. D.).

Mecomma gilvipes (Stål).

B. C.—Saanich Dist., V. I., Aug. 13, 1918 (W. D.).

Macrotylus multipunctatus Van Duzee.

B. C.—Vernon, June 10, 1918 (R. C. T.).

Van Duzee writes that this is the second specimen of the species he has seen.

Plagiognathus moerens Reuter.

B. C.—Vernon, June 18, 1917 (R. C. T.).

Plagiognathus obscurus Uhler.

B. C.—Royal Oak, V. I., July 24, 1917 (W. D.); Victoria, V. I., July 31, 1918 (W. D.).

This and the preceding determined by Van Duzee.

Bolteria picta var. *hirta* Van Duzee.

B. C.—Vernon, June 10, 1918 (M. H. R.).

Two specimens in poor condition which Van Duzee determines with some doubt.

Campylomma verbasci (Meyer-Dür).

B. C.—Royal Oak, V. I., Sept. 13, 1917 (W. D.); Vernon, Aug. 12, 1917 (M. H. R.).

Family GERRIDAE

Gerris remigis Say.

B. C.—Saanich Dist., V. I., May 6, 1917 (J. D. T.), Oct. 17, 1917 (W. D.); Vernon, 1908.

Limnoporus rufoscutellatus (Latreille).

B. C.—Saanich Dist., V. I., June 18, 1918, Sept. 1, 1917 (W. D.); Vernon, May 5, 1915, (M. H. R.).

Family NOTONECTIDAE

Notonecta undulata Say.

B. C.—Saanich Dist., V. I., Sept. 1, 1917 (W. D.).

Notonecta insulata Kirby.

B. C.—Okanagan Landing, May 2, 1916 (E. M. A.); Vernon, Apr. 29, 1918, Dec., 1908 (M. H. R.).

Family BELOSTOMATIDAE

Lethocerus americanus (Leidy).

B. C.—Kamloops, June 20, 1914 (W. D.).

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ACANTHOCEPHALA FROM FISHES OF DOUGLAS LAKE, MICHIGAN[1]

BY H. J. VANCLEAVE

The writer has recently described two new species of Acanthocephala, *Neoechinorhynchus crassus* and *Octospinifer macilentus*[2], from the common sucker of Douglas Lake, Michigan. Of these the latter represents a new genus. The specimens forming the basis for these descriptions were from the extensive collections taken by Dr. George R. La Rue during the summer of 1912 in connection with investigation at the University of Michigan Biological Station. In the course of his investigation more than 375 specimens representing sixteen different species of fish were examined for parasites. The Acanthocephala obtained in this extensive piece of work together with exceptionally complete data were sent to the writer for identification and study. Since no intensive study has been made upon the Acanthocephala of a habitat in North America similar to the one under consideration it seems desirable to present the results of this investigation. A number of new hosts have been discovered. These with biological data concerning a number of species, including a number of important negative findings, will add to the available data concerning this important group of fish parasites. In connection with the presentation of negative records it must be remembered that the period over which the examinations extended was restricted to the months of July and August. Thus there is a possibility that fishes not parasitized with Acanthocephala during these two months might harbor them at other seasons of the year. Such periodicity has been shown by the writer (1916) to occur in varying degrees in certain freshwater species of Acanthocephala.

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[1] Contributions from the Zoological Laboratory of the University of Illinois, No. 137.

[2] Illinois State Natural History Survey, Volume 13, Article 8. In addition to the descriptions of the two new species mentioned above the same work contains the description of *Pomphorhynchus bulbocolli* Linkins which is cited subsequently in this paper.

Reighard (1915) in his reconnaissance of the fishes of Douglas Lake has recorded twenty-two species of fish from this region. La Rue's examinations for parasites include data for sixteen of these species. Of the six species not represented in his records of examinations five are of rare occurrence in Douglas Lake, or at least have been infrequently taken in collections. These rare species of which no examinations are available are: *Notropis cayuga* Meek, *Etheostoma iowae* Jordan and Meek, *Cottus ictalops* (Rafinesque), *Lota maculosa* (LeSueur), and *Umbra limi* (Kirtland). The last of these according to Reighard has never been taken in Douglas Lake itself. Consequently it is apparent that records containing data for sixteen of the species make possible an unusually comprehensive survey of the Acanthocephala infesting the fishes of the vicinity.

Eight of the sixteen species of fish included in this investigation were found to harbor Acanthocephala. The percentages of infestation and the number of species of parasites found varied broadly in the different hosts. In the following section an analysis of the acanthocephalan infestation is given for each host species.

List of Species Infested with Acanthocephala

Catostomus commersonii (Lacépède). Common Sucker.

Specimens examined: 15. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
Pomphorhynchus bulbocolli Linkins, only	4
Octospinifer macilentus VanCleave, only	1
Neoechinorhynchus crassus VanCleave *Pomphorhynchus bulbocolli* Linkins	2
Pomphorhynchus bulbocolli Linkins *Echinorhynchus thecatus* Linton	1
Pomphorhynchus bulbocolli Linkins *Neoechinorhynchus crassus* VanCleave *Octospinifer macilentus* VanCleave	2

Though four species of Acanthocephala were found in this host they were so distributed among individuals that no host specimen harbored representatives of more than three species. A few instances of simple infestation were recorded. Four individuals bore *Pomphorhynchus bulbocolli* only, while one carried a simple infestation of *Octospinifer macilentus*. *P. bulbocolli* was present in nine of the ten infested individuals. One specimen examined Aug. 5, 1912, harbored nearly three hundred fully matured parasites of this species, while other individuals collected at approximately the same time revealed but a very slight infestation. No satisfactory explanation has been found for this great variability in degree of infestation within the same host species from the same locality. It may be due to individual differences in food habits of the hosts or to a strict localization of centers of infestation. If fishes bearing parasites which are discharging embryos frequent a restricted locality where suitable primary hosts occur in abundance, such an area might easily become a localized center of infestation. The individual fishes by chance or by choice habitually using such a center of infestation as a feeding ground would acquire heavy infestations of Acanthocephala. Other individuals feeding where infested primary hosts were less abundant would acquire relatively few parasites. It might be even possible for individuals to entirely avoid infestation because of individual peculiarities in selection of food.

Catostomus commersonii from the region under consideration is the type host for *Neoechinorhynchus crassus* and for *Octospinifer macilentus*. The former of these parasites was present in about 27% of the suckers examined and always occurred in association with one or two other species of Acanthocephala. *O. macilentus* appeared in 20% of the hosts. In one instance it constituted the sole infestation while in the remaining records it appeared along with both *N. crassus* and *P. bulbocolli.*

One specimen yielded two representatives of *Echinorhynchus thecatus.* While these were both fully mature individuals it seems probable that they represent an accidental infestation. The fact that members of this species may find lodging in the sucker and there reach sexual maturity indicates that there is no physiological barrier to the establishing of this species as a normal parasite of the sucker. The only apparent explanation of its general absence in the sucker must lie in the fact that neither primary nor intermediate hosts of *E. thecatus* enter into the food supply of this fish.

The sucker is by far the richest in acanthocephalan fauna of any of the fishes found in this region. One of its parasites, *N. crassus,* is yet unknown for any other host as well as from any other locality. The diversity of its acanthocephalan infestation offers a number of interesting biological problems for consideration. Conditions for existence for the sucker are apparently not very favorable in Douglas Lake. This is probably one of the reasons for the great diversity in infestation. Professor Reighard (1915:225) has called attention to the large numbers of dead suckers that are thrown upon the beach during the summer. According to his observations they present strong evidence of starvation for they do not seem to be diseased "and are not usually parasitized heavily enough to account for their emaciation." If lack of proper quantities of suitable food may cause the death of numbers of individuals of this species it is not an unwarranted assumption that many individuals are led to take as food, organisms which under normal conditions are not included in the diet of members of this species. In this manner parasites not normally found in the digestive tract of this species find entrance with the unusual food substances taken by the starving fish. It is apparent that the primary or intermediate host of *Echinorhynchus thecatus* cannot normally serve as any conspicuous portion of the food supply of the sucker, for at the season when other species of fishes in the same locality are carrying heavy infestations of this parasite but one individual of *C. commersonii* carried a light infestation of this species. Its entrance into the intestine must have been due to some unusual circumstance such as that mentioned above.

La Rue's field notes show that of the fifteen specimens examined only seven were adult. Of these adult specimens only one was free from infestation and the epithelium lining the intestine of this one showed thickened patches surrounding pits which were evidently the scars left by the removal of proboscides from an earlier acanthocephalan infestation. All of the purely negative records for this species are thus based upon examinations of immature fish.

Micropterus dolomieu Lacépède. Small-mouthed Black Bass.

Specimens examined: 10. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
E. thecatus Linton, only	8
P. bulbocolli Linkins *E. thecatus*	2

M. dolomieu is preeminently the definitive host of *E. thecatus* in the region under consideration. Every fish examined contained this parasite in the digestive tract in numbers ranging from a single specimen to more than a hundred. In one host two individuals were removed from cysts, one from the ovary and one from the liver. In both these instances the parasites were small and immature. This would indicate that their presence outside of the digestive tract resulted from adaptability of the bass to the role of intermediate host for this species. This same species was frequently taken from the stomach of the host though the intestine and pyloric caeca seem to be the normal and more usual habitat.

A single specimen of *P. bulbocolii* was taken from the intestine of each of two hosts. Both of them were normal mature individuals.

Micropterus salmoides (Lacépède). Large-mouthed Black Bass.

Specimens examined: 4. Infested with Acanthocephala: 4.

Echinorhynchus thecatus is the only species of Acanthocephala discovered in the large-mouthed black bass of this locality. It occurred in each of the four individuals examined, though in much smaller numbers than encountered in *M.*

dolomieu. The number in a single host individual varied from one to five as a maximum.

The minute size of the representatives of *E. thecatus* found in this species is noteworthy in that it gives a probable clue to a periodicity in the life cycle of this species. All of the specimens of *M. salmoides* in this collection were examined about three weeks earlier than any of those of *M. dolomieu.* Since individuals of *E. thecatus* from the last named host were much the larger, many of them fully mature, and much more numerous than in *M. salmoides,* it seems that evidence is here presented of a periodicity in life cycle of the parasite. Since hosts taken the second week in July carried but few immature parasites while those taken the first week in August were heavily infested with sexually mature parasites there is probably a season of the year when *E. thecatus* is absent from the digestive tract of its normal definitive host. This is borne out by the evidence of an infestation period beginning in June or early July for the locality under consideration.

Ambloplites rupestris (Rafinesque). Rock Bass.

Specimens examined: 10. Infested with Acanthocephala: 7.

Analysis of Infestation

Species represented in individual host	No. of instances
E. thecatus Linton, only	5
P. bulbocolli Linkins, only	1
E. thecatus *P. bulbocolli*	1

E. thecatus is the most characteristic acanthocephalan of this host. Infestations were extremely light, single specimens being encountered frequently. The maximum infestation for an individual of this species comprised eighteen individuals of *E. thecatus* and a single one of *P. bulbocolli.* One host carried a single gravid female of *P. bulbocolli* attached to the wall of the intestine.

A cyst in the stomach wall of one host individual yielded a single specimen of what is apparently *E. thecatus*.

Percina caprodes (Rafinesque). Log-perch.

Specimens examined: 13. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
E. thecatus Linton, only	6
P. bulbocolli Linkins, only	1
E. thecatus *P. bulbocolli*	3

This species apparently serves *E. thecatus* both as intermediate and as definite host. Numerous cysts bearing *E. thecatus* were encountered, especially in the mesentery. All of the intestinal forms encountered were immature. However, the examinations were all made early in July. It has been pointed out previously that *E. thecatus* is apparently entering the infesting stage at about this time. It is consequently impossible to determine whether this host serves normally as a definitive host or whether the parasites were taken into the digestive tract and had not yet found time to encyst as would be the case if this species served only as intermediate host.

Pomphorhynchus bulbocolli is a normal intestinal parasite of this host, though it also is found in cysts. One specimen bore five normal adults attached to the intestine wall.

Reighard (1915) has referred to the association of the log-perch and suckers at the breeding season. It is possible that the encysted larvae in the bodies of the log-perch may be responsible to some extent for the infestations of Pomphorhynchus and of Echinorhynchus found in the sucker. The rare occurrence of *E. thecatus* in the sucker would indicate that it finds entrance with some uncommon food substance. Thus two possibilities present themselves, either that the suckers occasionally feed upon the log-perch or the eggs of the log-perch may carry larval Acanthocephala with them at the time of their discharge from the body, thereby bringing an infestation into the suckers which are known to feed upon the eggs of the log-perch.

Perca flavescens (Mitchill). Yellow Perch.

Specimens examined: 168. Infested with Acanthocephala: 2. A single specimen of *E. thecatus* was removed from the stomach of *P. flavescens*; and but one other individual was found in the washings from the intestines of forty fish of the same species. Of the 168 specimens of this fish examined, only 25 were searched minutely. The remaining 143 were not so thoroughly studied. In these the digestive tracts were removed and slit open. Shaking the opened intestine in salt solution usually secures representative samples of the worm parasites when the liquid is decanted. Even granting the probable escape of small, securely fixed specimens by this method, the carefully studied 25 individuals give ample evidence of the practically complete freedom of the perch in this region from attack by Acanthocephala.

Esox lucius Linnaeus. Common Pike.

Specimens examined: 10. Infested with Acanthocephala: 2. *Echinorhynchus thecatus* was the only species of Acanthocephala discovered in this host. Of the two infested specimens one bore five parasites and the other a single one. All of these were small individuals, apparently not sexually mature, though collected in August when this species of parasite is mature in other hosts.

Ameiurus nebulosus (LeSueur). Common Bullhead.

Specimens examined: 2. Infested with Acanthocephala: 2. Two dead specimens belonging to this species were picked up from the beach. A single specimen of *P. bulbocolli* was attached in the intestine of one of these, while the other bore two intestinal cysts each containing a young form of this same species of parasite.

LIST OF SPECIES NOT INFESTED WITH ACANTHOCEPHALA

Representatives of the following species were examined without revealing any evidence of acanthocephalan infestation. The number preceding each species name indicates the number of individuals examined.

6 *Leucichthys* sp.? Herring.

2 *Eupomotis gibbosus* (Linneaus). Pumpkin Seed.

9 *Lepomis pallidus* (Mitchell). Blue-gill.

117 *Notropis hudsonius* (DeWitt Clinton) Spot-tailed Minnow.

1 *Notropis cornutus* (Mitchell). Common Shiner.

5 *Percopsis guttatus* Agassiz. Trout-perch.

2 *Pimephales notatus* (Rafinesque). Blunt-nosed Minnow.

2 *Semotilus atromaculatus* (Mitchill). Horned Dace.

NEW HOST RECORDS

As a result of this investigation a few new host records have been added to those previously recorded for *E. thecatus* and for *P. bulbocolli.*

New hosts for *E. thecatus*: *Catostomus commersonii, Esox lucius, Percina caprodes.*

New hosts for *P. bulbocilli*: *Catostomus commersonii Percina caprodes, Micropterus dolomieu, Ambloplites rupestris.*

HOSTS OF SPECIES OF ACANTHOCEPHALA KNOWN FROM DOUGLAS LAKE

The following table lists the host of each of the species of Acanthocephala considered in this study and in each instance indicates the relative abundance of the species of parasites in individuals of the host species.

Species of Acanthocephala	Host species	Relative infestation
Echinorhynchus thecatus Linton	*Micropterus dolomieu*	Abundant*
	Percina caprodes	Moderate
	Ambloplites rupestris	Slight**
	Micropterus salmoides	Slight
	Catostomus commersonii	Rare
	Perca flavescens	Rare
	Esox lucius	Rare
Pomphorhynchus bulbocolli Linkins	*Catostomus commersonii*	Slight
	Percina caprodes	Slight
	Micropterus dolomieu	Rare
	Ambloplites rupestris	Rare
	Ameiurus nebulosus	Rare
Octospinifer macilentus VanCleave	*Catostomus commersonii*	Moderate
Neoechinorhynchus crassus VanCleave	*Catostomus commersonii*	Moderate

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* Words indicating relative degree of infestation have been assigned arbitrary value as follows:

Abundant—more than 50 parasites of the species under consideration found in at least some individuals of the host.

Moderate—of frequent occurrence but never more than 50 in a host individual.

Slight—never more than 10 parasites of this species in an infested host individual.

Rare—not more than 1 or 2 parasites of this species in an infested host individual.

**One individual had a "Moderate" infestation.

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NEW SPECIES OF AMNICOLA FROM GUATEMALA

BY BRYANT WALKER

The Amnicolidæ collected by Mr. A. A. Hinkley during his visit to Guatemala in the winter of 1912-1913 were placed in my hands for identification. Owing to the lack of material deemed necessary for purposes of comparison, which has only recently been obtained, the determination of the species represented in the collection has been delayed until the present time.

The following species of Amnicola seem to be new.

I

Amnicola cisternina n. sp. Pl. I, fig. 1.

Shell broadly conic, umbilicate, greenish horn color, smooth and shining, the lines of growth being regular and very fine; the apex is small and immersed so that it does not appear when the shell is viewed from the front, thus it has then apparently an obtuse apex; whorls 4½, rounded and separated by a deeply impressed suture, body whorl large, ventricose and regularly rounded; aperture large, broadly rounded nearly circular from the upper insertion of the lip to the base of the columella; lip sharp, slightly thickened within, giving a beveled appearance to the inner margin, continuous, but slightly adnate to the body-whorl between the umbilicus and the upper insertion of the lip, but its curve is not impinged upon by the body-whorl, umbilicus fairly wide.

Alt. 3.75, diam. 2.75, aperture alt. 2 mm.

Reservoir north of Guatemala City, Guatemala.

Types No. 47161 Coll. Walker. Cotypes in the collections of A. A. Hinkley, the Philadelphia Academy and the Museum of Zoology, Univ. of Mich.

This well marked species is evidently related to *Amnicola stolli* v. Mts., which was found in a very similar situation, i. e., wells in the town of Antigua, Guatemala, but differs in being larger and more ventricose and in the larger and broadly rounded aperture. In *stolli,* according to the figure, although it is not mentioned in the very brief description, the body-whorl is apparently obsoletely angled at the periphery and the aperture is distinctly angled above owing to the flattening of the upper portion of the lip; whereas in *cisternina* the body-whorl is regularly rounded and the upper portion of the lip is expanded in a semi-circular curve.

As usual in the genus two forms, probably sexual, are represented. The figured type is the more slender and is presumably the male. An example of the more inflated form has the same number of whorls as the type, measures alt. 3.5, diam. 3 mm. and has a somewhat wider umbilicus.

II

Amnicola panzosensis n. sp. Pl. I, figs. 2-3.

Shell small, ovate-conic, narrowly umbilicate, horn color, smooth and shining; whorls 4, the apical one small the remainder regularly increasing, body-whorl longer than broad; sutures well impressed; aperture ovate, slightly flattened on the basal margin; lip sharp, inner margin of the peristome adnate to the body-whorl.

Alt. (type fig. 2) 2.75, diam. 1. 75, aperture alt. 1.25 mm.

Panzos, Guatemala.

Types No. 37387 Coll. Walker. Cotypes in the collections of A. A. Hinkley, the Philadelphia Academy and the Museum of Zoology, Univ. of Mich.

This diminutive species is one of the smallest yet recorded from Central America. The *A. costaricensis* Mörch from Costa Rica (2 x 1.5 mm.) and *A. tryoni* Pils. from Nicaragua (2.3 x 1.6 mm.) are smaller. The obese form found with it (fig. 3) measures alt. 2.4, diam. 1.75 mm. and has a slightly wider umbilicus.

III

Amnicola conchensensis n. sp. Pl. I, figs. 4-5.

Shell ovate-conic, umbilicate, horn color, smooth and shining; spire elevated, conical; whorls 5, regularly rounded, with a well impressed suture, apical whorl small and projecting, body-whorl longer than broad; aperture broad oval, slightly flattened on the basal margin; lip sharp, inner margin of the peristome adnate to the body-whorl; umbilicus narrow.

Alt. (type fig. 5) 3.5, diam. 2.5, aperture alt. 1.6 mm.

Cochens River, Guatemala.

Types No. 38508 Coll. Walker. Cotypes in the collections of A. A. Hinkley, the Philadelphia Academy and the Museum of Zoology, Univ. of Mich.

This species is well characterized by its elevated, conical spire and acute apex. At first sight it looks like an enlarged edition of the preceding species, but it differs in the greater elevation of the spire and acute apex as well as in size. The obese form found with it (fig. 4) measures alt. 3, diam. 2.25 mm.

IV

Amnicola hinkleyi n. sp. Pl. I, fig. 6.

Shell turreted conic, narrowly umbilicate, greenish horn color, smooth and shining; spire elevated, conical; whorls 5, convex, separated by a deep suture, apex somewhat obtuse, body-whorl ventricose, about as long as broad; aperture subcircular, slightly flattened on the outer margin; inner margin of the peristome thin, appressed to the body whorl for a short distance above the umbilicus.

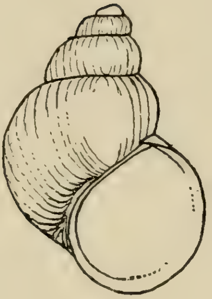
Alt. 5.25, diam. 3.5, aperture alt. 2.5 mm.

Reservoir north of Guatemala City, Guatemala.

Types No. 47162 Coll. Walker. Cotypes in the collections of A. A. Hinkley, the Philadelphia Academy and the Museum of Zoology, Univ. of Mich.

This is one of the largest species yet recorded from Guatemala. It seems to be more closely allied to the Mexican *A. orizabensis* C. & F. than to any of the described Guatemalan species. It differs from that species in being narrowly umbilicated, less inflated and with a more elevated spire. The obese form found with it measures alt. 4.5, diam. 3.25 mm. and as usual has a slightly wider umbilicus.

NEW AMNICOLAE PLATE I



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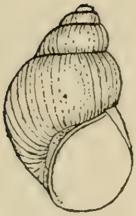

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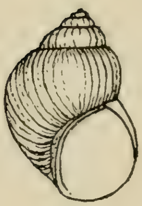

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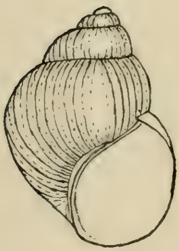

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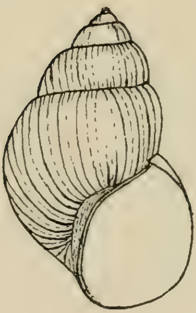

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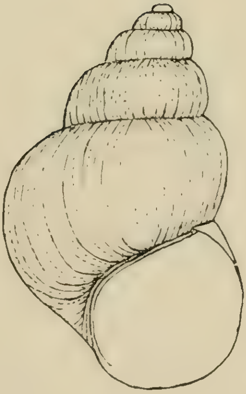

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OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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NOTES ON NORTH AMERICAN NAIADES. II

BY BRYANT WALKER

I

UNIO TENERUS Ravenel, Pl. I, figs. 1-6.

Unio tenerus Ravenel, Catalogue, 1834, p, 7; Conrad, Pr. A. N. S. P., VI, 1853, p. 258; H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 492; Simpson, Pr. U. S. N. M., XV, 1892, p. 416, pl. LVIII, figs. 5, 8.

Margarita (*Unio*) *tenerus* Lea, Syn., 1836, p. 39; 1838, p. 25.

Margaron (*Unio*) *tenerus* Lea, Syn., 1852, p. 39; 1870, p. 44.

Lampsilis ogeecheensis Simpson, (*pars*) Syn., 1900, p. 551; Desc. Cat., 1914, p. 110.

Lampsilis modioliformis (*pars*) Simpson, Syn., 1900, p. 559; Desc. Cat., 1914, p. 135.

Lampsilis tenerus Mazyck, Cont. Charleston Mus., II, 1913, p. 23.

This species has had a very unfortunate history. It was never described by Ravenel. In his Catalogue of 1834, he simply cites the name as "new?" and gives the locality as Cooper River, S. C.

Ravenel seems to have found his species in considerable abundance as there are good sets of it in both the Lea Collection in the National Museum and in the Philadelphia Academy, and Dr. James Lewis had five specimens in his collection, now in my possession, which he received from Dr. Lea.

As stated by Lea (Rectification, Rev. Ed., 1872, p. 36), having received the species from Ravenel under the MSS. name of *tenerus,* he recognized it as valid species in all of his synopses from 1836 to 1870, although no description had been published. He never described or characterized it in any way himself.

Conrad in his Synopsis of 1853 (l. c.) recognized the species as a valid one.

H. and A. Adams (l. c.) simply cite the species as a valid one in one of their groups of the Naiades.

Simpson in his Synopsis, 1900, p. 559, gives two references to Hanley's works, which I have not been able to verify.

In his paper on the Unionidae of Florida (1892, l. c.), Simpson figured two specimens from the Lea Collection as *Unio tenerus,* but gave no description. In his Synopsis (l.c.) he states that he was mislead in his Florida paper by the fact that Lea had two different species in his collection under the name of "*tenerus* Rav." and that the shells there figured are *prevostianus* Lea=*ogeecheensis* Con. and placed what he considered the genuine *tenerus* under *modioliformis* Lea as a synonym. He pursued the same course in his Descriptive Catalogue of 1914.

In 1913 Mazyck (l.c.), having found two examples in the Ravenel collection, published a short description of the species and remarked: "The shell is very close to *Lampsilis ogee-*

cheensis Conrad (*prevostianus* Lea) and is about midway between that species and *L. modioliformis* Lea and may best be considered a variety of the former."

Through the courtesy of Mr. Mazyck I have had the opportunity of examining these specimens and have had them photographed and they are reproduced on pl. I, figs. 1-4.

While in Washington and Philadelphia in 1918 I took occasion to compare the Lewis examples with those in the National Museum and the Philadelphia Academy and found that they agreed exactly with those in these collections.

As stated by Simpson, there are two sets representing different species in the Lea Collection under the name of *tenerus* Rav. One is undoubtedly the *modioliformis* of Lea and the other is the species represented by Ravenel's own specimens and that figured by Simpson in his Florida paper.

Simpson, no doubt, was lead to change his opinion as to what was really Ravenel's *tenerus* by the fact that Lea in his synopses had placed it next to or near his *modioliformis*. But the fact that Lea distributed the other species as "*tenerus* Rav." would go to show that he considered that to be really Ravenel's species.

Both of Ravenel's specimens are females and that represented by figs. 1 and 2, being mature, may be considered as the type. It has written on the inside of the right valve in Ravenel's handwriting, "*U. tenerus* Ravenel—female." It measures: length 52, alt. 32, diam. 21 mm. It is a thin shell, smooth, yellowish-brown with darker rest-marks, deeper brown towards the beaks, faintly rayed with green; the beaks are eroded; the right valve has a thin, triangular and erect pseudocardinal tooth and an obsolete second one and a single lateral, low, long, thin and straight; the left valve has two pseudocardinals, thin, erect and nearly in the same line and two laterals, thin, straight and close together; nacre bluish-white tinged with salmon towards the beak cavities and iridescent behind.

The other specimen (figs. 3-4) is also a female, about four-fifths grown and is accompanied by Ravenel's original label: "*Unio tenerus*—distinct—Lea. Indianfield bridge between ————(illegible) and Wantoot, St. Johns, B. C., So. Car." Mr. Mazyck writes: "Wantoot is the name of the old Ravenel Plantation on the Cooper River." It measures: length 41.5, alt. 26.5, diam. 16 mm. The epidermis is a reddish-yellow and is more distinctly rayed than the type. The nacre and hinge are the same.

There are evidently considerable individual differences in coloration. All of the Lewis shells are of a greenish-yellow, distinctly rayed with dark green, the rays being more or less interrupted by the lines of growth. But both at Washington and Philadelphia there are shells similar to the Ravenel specimens as above described and also those colored like the Lewis examples.

In order to complete the exposition of the species I have added figures (figs. 5-6) of the largest male shell (No 15754, Coll. Walker) in the Lewis set. It agrees with the remainder of the set in color and in being more distinctly rayed than Ravenel's types.

As Mr. Mazyck well says (l. c.), the discovery of these shells "seems to solve all doubt concerning the species and set at rest the guess work of students of the American Naiades."

There still remains the question as to its position in the system.

It seems clear that Ravenel's name can not be retained in any event. It must be held to date from 1892 when for the first time it was correctly figured, though not described, by

Simpson. But in 1840 Lea described an entirely different species as *Unio tener,* which is now known as *Lampsilis tenera* (Simpson, Desc. Cat., p. 122). I do not find any Latin adjective as *tenerus,* but if construed as such the feminine form would be *tenera* and, therefore, could not be used either in a specific or varietal sense in Lampsilis, although in Unio the two names would undoubtedly be considered sufficiently distinct.

It hardly seems possible that *tenerus* could be construed as a word "formed by an arbitrary combination of letters (Code, Art. 8-k), but if so, Mazyck's use of *Lampsilis tenerus* might be retained either in a specific or varietal sense.

I fully agree with Mazyck that Ravenel's species "is very close to *Lampsilis ogeecheensis* Con." and "may best be considered a variety" of that species. Unfortunately our knowledge of Conrad's species is very limited. The types do not seem to be in the collection of the Philadelphia Academy and I am not aware of the existence of any authentic specimens. It is not represented at all in the Lea Collection. We are consequently restricted to the original description and figure.

Then, too, our knowledge of Lea's species, *vaughanianus* from Camden, S. C., *prevostianus* from the Etowah River, Ga., and *proximus* from "Georgia" and their relations to Conrad's species is still too imperfect to enable us to arrive at any definite conclusions at the present time. From an examination of the types I fully concur in a suggestion of Frierson's that *concavus* and *sudus* of Lea should also be included in the same category. In this general uncertainty it is impossible to fix the standing of Ravenel's species any more definitely than Mazyck has done and there seems to be no other way than to leave it for the present in that very unsatisfactory position.

Both Lea and Conrad agree in referring Conrad's *U. tene-*

brosus to this species and if it is the same Conrad's name would have precedence. Conrad states that he received two specimens from the Rappahannock, River. Va., and that he found a single specimen in South Carolina. He does not state from which locality his figured type came. No representatives of the species grouping around *ogeecheensis* have been found as far north as the Rappahannock and as *L. radiata* Gmel. is found all through that region, Simpson's reference (Desc. Cat. 1914, p. 65) of *tenebrosus* to that species would seem to be probably correct.

II

LAMPSILIS MODIOLIFORMIS (Lea). Pl. II, figs. 1-4.

As the preceding species has been referred to this by Simpson (l. c.), it seems well to consider both at the same time.

The type of this species was received by Lea from Ravenel and came from the Santee Canal, S. C. Although Simpson (Desc. Cat., p. 135) extends its range from that locality "south to north Florida; probably west to Mississippi," my own experience agrees with his that "all the valid specimens I have seen are from the Santee Canal, S. C." I have examined the shells from Mississippi doubtfully cited by him as this species and am of the opinion that they should be referred to *L. vibex* Con. In his paper on the Unionidæ of Florida (Pr. U. S. N. M., XV, 1892, p. 414) Simpson referred to this species several of Lea's species and one of Wright's that he subsequently in his Synopsis and Descriptive Catalogue very properly transferred to the synonymy of *L. vibex* Con. It is possible that his retention of the extension of the range of *modioliformis* to Florida may have been a relic of his former opinion in regard to its synonymy.

Lea's figured type is an old female and the posterior expansion is more developed than in the other specimens I have seen. Figure I on plate II is of a specimen now in the Ravenel collection, kindly forwarded to me by Mr. Mazyck, and better represents the female shell as usually found. It measures: length 58, alt. 33, diam. 20 mm. It is very smooth and of a waxy appearance (which seems to be quite characteristic of the species), brownish-yellow with the rest-marks well indicated, with indistinct, broad, green rays becoming deeper towords the posterior margin; hinge very slight, much as in *L. lienosa* (Con.). Inside of the left valve is written in Ravenel's hand, "*modioliformis.*"

The male shell has never been figured. Among the Ravenel shell submitted to me by Mr. Mazyck was one, on the inside of one of the valves of which Ravenel had written, "Distinct from *modioliformis*. Mr. Lea says it is *modioliformis.*"

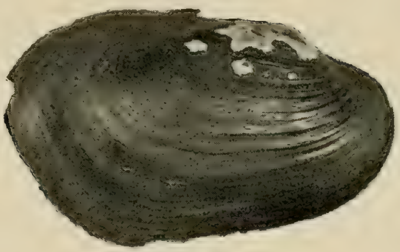
This specimen (Pl. II, figs. 2-3) agrees very exactly with those in the Lea Collection and is unqeustionably the male of the species. In Ravenel's time the sexual dimorphism in the Naiades was not well understood and without that appreciation the two forms are so different that Ravenel's opinion can be easily understood.

This shell is of a dark yellowish-brown, very indistinctly rayed posteriorly; smooth, but somewhat ridged along the rest-marks; the hinge is similar to that of the female. It measures: length 53.5, alt. 27.5, diam. 19.5 mm.

The shell figured on Pl. II, fig. 5, was received by Lea from Ravenel and by him given to Dr. Lewis and is now No. 15,753 Coll. Walker. It is apparently a female, but is more inflated than the Ravenel specimen (fig. 1) and is much less expanded posteriorly. In all other respects it is quite similar. It measures: length 54, alt. 29, diam. 22.5 mm.

Taking only the "valid" specimens into consideration, *modioliformis* is a very consistent type and fairly entitled to specific rank.

Lampsilis delumbis (Con.), from small streams near Cooper River, S. C., has been considered by both Lea and Conrad as being this species and there was the usual dispute between them on the question of priority. If they are the same, Conrad's name has several months priority. But Simpson (Desc. Cat., p. 52) has considered *delumbis* as distinct and placed it in another group near *L. ochracea,* and until his decision is overruled by sufficient authority that question may be considered as settled to the contrary.



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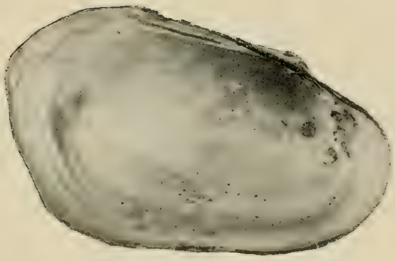

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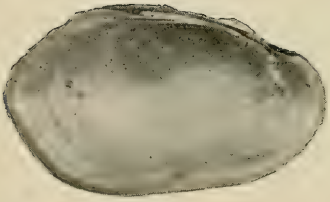

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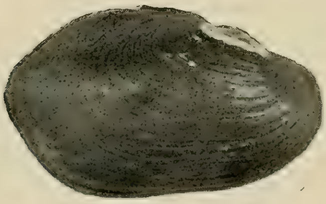

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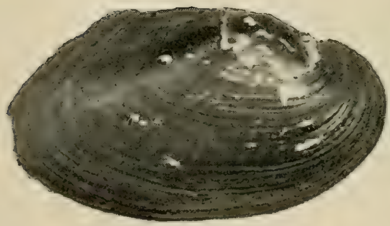

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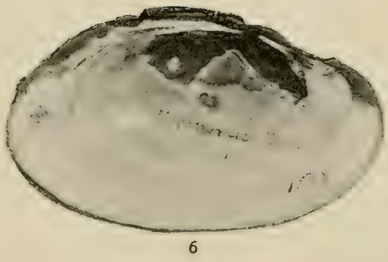

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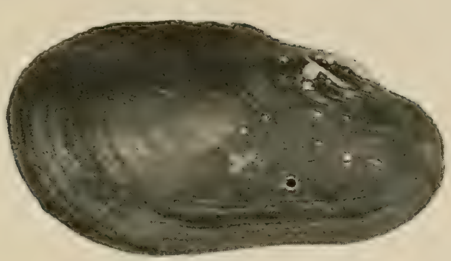

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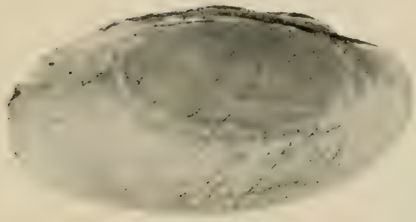

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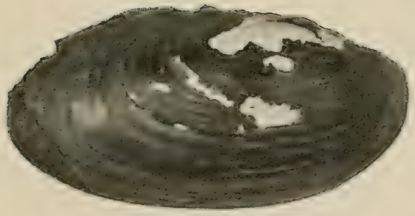

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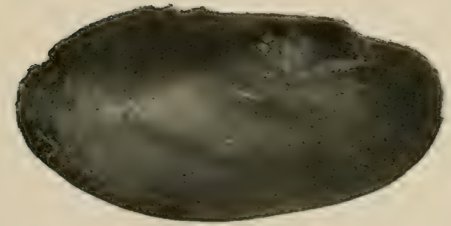

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THE WATERBUGS (HEMIPTERA) OF THE DOUGLAS LAKE REGION, MICHIGAN[1]

BY ROLAND F. HUSSEY

Douglas Lake is located about seventeen miles south of Mackinaw City, in the northern tip of the southern peninsula of Michigan, about midway between Lake Huron and Lake Michigan, at an elevation of 712 feet above sea-level. It is fed by two small streams which flow into the north side of the lake, at the east and the west ends respectively, and it drains into Burt Lake, two miles to the south, through Maple River, a small winding stream which has its source in the west end of Douglas Lake. Within a radius of eight miles there are six other lakes of various sizes.

Douglas Lake is about three and three-quarter miles long, and its maximum depth is about 85 feet. The sandy beach extends out into the water for a short distance, and is terminated by an abrupt drop-off beyond which there is no emergent vegetation. Along the east shore the beach reaches its maximum width, and here there are considerable areas of sand, exposed to strong wind and wave action, and a sparse vegetation. On the east and north shores there are several beach pools in various stages of formation, from which some of the best collections of Hemiptera were made. The region about Douglas Lake is very sandy, and there are no extensive marsh areas in the vicinity; the plant associations developed on low moist ground are of the cedar-sphagnum bog type.

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[1] Contribution from the Biological Station of the University of Michigan.

In the present article an attempt has been made to list as completely as possible the aquatic Hemiptera found in this part of Michigan. The hemipterous fauna of the state has as yet been studied only incidentally, in connection with other problems, and published records for the various species are very few indeed. This report is based on collections made by Miss Eva G. Miller in 1913, by Miss Miller and others in 1914, and by Miss Priscilla Butler and myself in 1918. Use has also been made of an unpublished manuscript by Miss Miller on her collection of 1913. The field work was done under the direction of Professor Paul S. Welch, in the months of July and August, during the regular session of the University of Michigan Biological Station, which is located on Douglas Lake.

The species found here were for the most part determined by the writer. Special acknowledgments are due to Professor J. F. Abbott for determination of several species of the Corixidae, and to Mr. J. R. de la Torre-Bueno for identification of several of the other forms, as well as for verification of the determinations of the writer.

FIELD STATIONS

In order to facilitate collection, and for convenience in keeping records, twelve stations were selected for field work, in 1913, which included the different habitat types found in the vicinity. Collections were made at frequent intervals during the summer at most of these stations, but a few of them were visited only once or twice. The same plan was followed during the other years, though somewhat less systematically in 1914.

Station I was the site of the Biological Station itself, on the south-east shore of South Fishtail Bay, and was selected as a matter of convenience. Only insect drift, washed up on the bare sandy beach, was found here.

Station II was a portion of the east shore, about 100 yards long, where the beaches were unusually wide. It was completely exposed to wind and to wave action, and received a maximum amount of light. Here were a number of small standing pools which were cut off from the main lake by the inwash of sand and by the falling of the water level of the lake during the summer. The vegetation consisted chiefly of rushes (Scirpus spp.), with some Equisetum and a few scattered grasses and sedges. The insects found here were chiefly Diptera, tiger-beetles, ants, and grasshoppers, and were most numerous near the edge of the water. *Gerris marginatus* and *Saldula pallipes* were the only Hemiptera taken at this station.

Station III was a series of exposed beach pools on the east shore near North Fishtail Bay. During July, as the water level in the lake dropped rapidly, the pools at the south end of the group dried up, and most of the collecting was done in the north-east pool of the series.

At the beginning of the summer the water in this pond covered an area some thirty-five yards in diameter, and was connected directly with Douglas Lake by a narrow channel through the low sandy bank which separated the two bodies of water. Emergent and floating vegetation extended in from all sides and covered the pool, except for an open-water area of about twenty-five by seventy feet where a wagon road cut through the pond. The maximum depth of water here was about twelve inches. In the part of the plant zone occupying the deepest water the vegetation consisted of a species of Potamogeton, together with Utricularia and scattering *Scirpus validus;* surrounding this was a zone of sedges (*Carex filiformis*), *Iris versicolor,* Phragmites, and other plants of similar habit. The bottom was quite mucky, with scattered areas of almost clean sand and of partly decayed leaves, etc. Besides the Hemiptera, frogs, tadpoles, young catfish, small crustacea, insect larvae of various orders, and certain beetles were quite abundant.

At the end of August the water in this pool was reduced to an area about five by thirty feet in extent, and the consequent concentration of the aquatic life made collecting very easy.

Some collecting was also done in the adjacent pool, about fifteen yards west of the first. This pool was a little smaller than the other, and had no direct connection with it or with the lake. The bottom here was rather marly, with Chara, Equisetum, and Scirpus forming the dominant vegetation. The fauna of the two pools was quite similar.

Station IV was the small cove at the south-west corner of North Fishtail Bay. It covered an area of about half an acre, and was partially separated from the main lake by a wooded point on the south, which curving northward in an L-shaped tongue, effectually protected this little cove from wind and waves. Trees and bushes grew down to the edge of the water on the west, south, and east.

The water here was clear, and not over eighteen inches deep in most of the cove; and, being sheltered from wave action and exposed to the sun, it tended to follow the temperature of the air more closely than did the main body of the lake. The bottom was originally clean sand, but admixture with organic debris had made it rather mucky in places. Water-lilies grew plentifully in the deeper parts, bordered with irregularly distributed bunches of Vallisneria and Potamogeton, while sedges grew rather thickly in the shallower parts of the cove.

Amphipods, Odonata, various beetles (Dytiscidae, Gyrinidae, Donacia), tadpoles, frogs, and schools of young fish were common here.

Station V was a small oval beach pool, about twenty by sixty feet in extent, on the north shore of the lake near North Fishtail Bay. It was separated from the lake by a low sandy bank, beyond which a new beach pool was forming. The water here was only about eight inches deep, and rather turbid. The aquatic vegetation was fairly dense, and covered nearly the entire area of the pool: it consisted chiefly of Scirpus, Equisetum, and Carex. The fauna consisted principally of beetles, Odonata, Hemiptera, and Arachnoid forms.

Station VI was the larger of two adjacent beach pools on the north shore of Douglas Lake, which are known locally as the Sedge Pools. This pool, which proved to be the best station in the Douglas Lake region for collecting Hemiptera, was about 200 by 75 feet, with a central area of open water about 120 by 50 feet in extent. The water was about two feet deep in the center of the pool, and slightly turbid; and the bottom was very mucky, underlaid with sand. The aquatic vegetation around the open water was composed principally of Nymphaea, Sagittaria, Scirpus, Equisetum, and Carex, with some Phragmites, Vallisneria, and plants of similar habit; and along the north shore of the pond there was a thicket of willow and dogwood coming down to the water's edge. In the open water there was a small growth of submerged vegetation, consisting of a species of Potamogeton.

Tadpoles, insect larvae, arachnids, and mollusks were common here.

Station VII was the lower part of Bessey Creek, a small stream having its source in Lancaster Lake and flowing southward a distance of about a mile into the north-west corner of Douglas Lake. Near the mouth, where the collecting was done, the stream was about thirty feet wide and from five to ten feet deep, and the current was very slow. Deciduous forest trees shaded the stream, and, except for occasional mud flats, the banks were covered with a thick growth of shrubs, ferns, and grasses. In the water, along the margins, were water lilies, eel-grass, Ceratophyllum, and species of Potamogeton.

Fish, tadpoles, crayfish, insect larvae of various kinds, Hemiptera, and water beetles were the most conspicuous animals at this station.

Station VIII was a portion of Maple River near its source at the west end of Douglas Lake. The stream was shallower and more rapid than Bessey Creek at Station VII, and flowed through open country. The littoral vegetation was fairly dense, bushes alternating with grassy banks and sandy flats, but the stream itself was free from vegetation other than occasional stands of rushes and sedges along its edges. The bottom was sand, with small areas of debris and muck in the back-eddies.

Station IX was a partially filled peat bog located a short distance from the shore at the south-west side of Douglas Lake. This station is known both as Silver Lake and as Bryant's Bog, the latter name being the one more commonly used at the Biological Station. The open-water area was roughly L-shaped, surrounded and overgrown on all sides by a floating mat of Chamaedaphne and Sphagnum. There was a "false bottom" about ten feet below the surface of the pond, and the whole bog was underlaid by a bed of peat some fifteen feet thick. The water was quite brown from long-continued leaching of organic matter. In several places there were small beds of water lilies, and in most of the pond there was a sparse growth of a species of Potamogeton, together with some Naias. Algae were rather plentiful.

Immature forms of Diptera and Odonata were common, as were also Hemiptera and Dytiscidae. The aquatic insects at this station were parasitized by red mites to a much greater degree than at any other station in the region.

Station X was the upper portion of Carp Creek, a small rapid stream fed by subterranean water coming to the surface in a number of springs about three-quarters of a mile south of Douglas Lake. The stream was heavily shaded, but what light was available penetrated to the bottom through the clear water of the creek. The bottom was sand, with only a very small amount of debris; and, except for occasional beds of Chara, the vegetation was confined almost entirely to the margins of the stream. As might be expected, there was a marked absence of predaceous animal forms, some surface-feeding Hemiptera being the exceptions. The immature forms of may-flies, caddis-flies, and black flies (*Simulium venustum*) were abundant.

Station XI was Lancaster Lake, a small body of water about a mile north of Douglas Lake, previously mentioned as the source of Bessey Creek. Collecting was done here in the marshy areas along the north and west shores. Among the rushes, reeds, and cat-tails there were occasional exposed marly flats and small pools of turbid standing water which received an abundance of light. Tadpoles, fish, amphipods, various insect larvae, Hemiptera, and water beetles were observed here.

No collecting was done at this station in 1918, and the 1914 specimens were confused with specimens from other stations, so that only the scanty records of 1913 are available for Lancaster Lake.

Station XII was a bog area about a mile south-east of Douglas Lake. Originally more than 250 feet in diameter, the open water has now been reduced to about 30 by 60 feet, with short narrow extensions to the north and south. The water was three or four feet deep in the center, over a very soft peat bed some fifteen feet thick. The vegetation in the open water was rather scanty, consisting of water lilies and some Potamogeton; and the floating mat at this bog consisted almost entirely of *Carex filiformis,* with only occasional shrubs of Chamaedaphne, and with no Sphagnum except at the north-west edge. The fauna here was very similar to that at Station IX.

In addition, one or two collections were made in 1914 at Monroe and Vincent Lakes, a short distance north of Douglas Lake; but they are not included in the present report, as no field notes were kept and the specimens were placed in vials of alcohol together with specimens from other localities.

Discussion of Species

Key to the Families of Waterbugs of the Douglas Lake Region

1. Antennae short, concealed in cavities on ventral side of head, near eyes; forms living in water 2

Antennae exposed, at least as long as head; littoral forms or forms living on surface of water 5

2. Head overlapping prothorax dorsally; body flattened above; apical abdominal segments of males asymmetrical..... CORIXIDAE

Head inserted into prothorax; male abdomen symmetrical; form of body variable 3

3. Hind tarsi with two distinct claws; size larger, length 19 mm. or more 4

Hind tarsi without two distinct claws (except in Plea, which is less than 3 mm. long); size moderate or small, length less than 16 mm.; swim with ventral side uppermost .... NOTONECTIDAE

4. Apical abdominal appendages long and slender, not retractile; hind legs not flattened; body long and slender (in our forms) .... NEPIDAE
   Apical abdominal appendages short and flattened, retractile; hind legs distinctly flattened; body broad and flat .... BELOSTOMATIDAE
5. Head shorter than thorax and scutellum together, eyes close to thorax 6
   Head as long as thorax and scutellum together, much produced in front of eyes, which are remote from thorax; body very slender; usually wingless............ HYDROMETRIDAE
6. Claws of at least the front tarsi distinctly subapical, with the terminal tarsal segment more or less cleft at tip.............. 7
   All tarsal claws situated apically 8
7. Hind femora (except in females of Rheumatobates) distinctly surpassing apex of abdomen; bases of antennae more or less remote from eyes, and anterior to them........... GERRIDAE
   Hind femora not or barely surpassing apex of abdomen; bases of antennae (in our forms, at least) contiguous to eyes or located beneath them .... VELIIDAE
8. Uusually apterous; hemelytra when present with clavus membranous, similar in texture to membrane, the latter without veins; body flattened above, convex below; color usually green; length about 3 mm.; live on surface of water or on floating vegetation .... MESOVELIIDAE
   Usually winged; clavus not membranous, membrane with four or five long closed cells; color not green; size larger; tylus separated from frons by an impressed line; littoral forms, rarely found in same situations as the Mesoveliidae.... SALDIDAE

FAMILY HYDROMETRIDAE, THE MARSH-TREADERS

This family is represented in Michigan by a single species.

GENUS HYDROMETRA LATREILLE

1. *Hydrometra martini* Kirkaldy. This interesting species was found in considerable numbers at two of the beach pools (Stations V and VI) and at Station XII, and a few individuals were taken at Station IX, where they were found on the surface of the water under the overhanging Chamaedaphne at the edge of the pond. Although fairly common in July, only a few individuals were seen in August. A single winged specimen was taken at Station VI on July 9, 1918.

FAMILY GERRIDAE, THE WATER-STRIDERS

Five species, belonging to two genera, have been taken at Douglas Lake.

Key to the Genera of Gerridae of the Douglas Lake Region

Inner margins of eyes convexly rounded; body comparatively paratively long and slender (Gerrinae); length 7 mm. or more .... GERRIS
Inner margins of eyes convexly rounded; body compartively short and broad (Halobatinae); length less than 6 mm......... 2
2. Basal segment of antennae nearly as long as other three together; antennae nearly as long as body (not yet taken at Douglas Lake) .... METROBATES
Basal segment of antennae much shorter than other three together, sometimes shorter than segments 2 and 3 together..... 3
3. Fourth antennal segment longer than third; color black, dorsal surface varied with yellow; occurs on sheltered parts of lakes (not yet found at Douglas Lake) .... TREPOBATES
Fourth antennal segment not more than equal to third; antennae and hind legs of males curiously distorted; color black above, more or less marked with yellow; usually found on slow-flowing streams................ RHEUMATOBATES

GENUS GERRIS FABRICIUS

The four species of Gerris occuring at Douglas Lake may be separated by the following key.

1. Basal segment of antennae longer than second and third together; usually wingless; length 12-13 mm.; occurs on running water .... *G. remigis*
Basal segment of antennae shorter than second and third together; usually winged 2
2. Antennae as long as half the body; 6th abdominal segment of male roundly emarginate below; length about 15 mm. .... *G. rufoscutellatus*
Antennae less than half as long as body, not longer than head and thorax together; 6th ventral segment of male doubly emarginate; length 10 mm. or less; dorsal surface black 3
3. Lateral border of anterior lobe of pronotum with a short longitudinal yellow line behind eye; median emargination of 6th ventral segment of male roundly rectangular; length 7-8 mm. .... *G. buenoi*
Lateral border of pronotum concolorous; median emargination narrow and rounded; length 9-10 mm. ...... *G. marginatus*

2. *Gerris remigis* Say. Found commonly in groups numbering about six to ten individuals on the back-eddies of the streams. Nymphs were found abundantly in company with the adults through July and August. A single specimen was taken on standing water at Station IV on July 7, 1918; and two winged specimens were secured on Maple River on July 11.

3. *Gerris marginatus* Say. This water-strider was found on all the beach pools, bogs, and sheltered portions of Douglas Lake, and also occasionally on back-eddies in the streams, and among bulrushes on more exposed parts of the lake. Though often taken at the same stations as *G. buenoi,* it was seldom found with that species, as it seemed to prefer more open water, while *buenoi* occurred most commonly among the vegetation. Brachypterous individuals were fairly common on Sedge Pool (Sta. VI) during July, but apterous individuals were rare.

4. *Gerris buenoi* Kirkaldy. The most abundant and widely distributed waterbug of the Douglas Lake region; found at all the stations except the rapid streams and the exposed situations on the large lake. Its habitat preferences have been mentioned under the preceding species: this was the only water-strider found commonly among Scirpus and Carex at the various pools. Apterous specimens were fairly common at Station VI during July, and two pairs of apterous adults were taken in copula, but no brachypterous individuals were observed.

5. *Gerris rufoscutellatus* Latreille. Less abundant than the two preceding species, but somewhat more common than *G. remigis.* The species was found at all the stations except the exposed parts of the large lake. On the pools and bogs it occurred in the same situations as *G. marginatus,* and, while

occasionally found in company with *G. remigis* on the streams, it appeared to prefer more slowly moving water than did that species.

The Douglas Lake specimens of *Gerris rufoscutellatus* vary somewhat in the coloration of the hemelytra, which in the majority of the individuals are concolorous. In two specimens the ground color is white, with only the nervures rufous, and other specimens show intergradation between this pattern and the typical coloration.

GENUS RHEUMATOBATES BERGROTH

6. *Rheumatobates rileyi* Bergroth. This little water-strider was found in great numbers on Bessey Creek, where on August 14, 1918, over one hundred adults were collected with three sweeps of a net. In the same locality, on July 25, about half a dozen nymphs of a later instar were taken on the sheltered cove in North Fishtail Bay (Sta. IV).

The adult specimens from Douglas Lake differ markedly in color from Ohio specimens of typical *rileyi* in my collection, and may possibly merit separation as a distinct variety. The connexivum and disk of the mesonotum are entirely black in the northern form, and the yellow marking of the pronotum of typical *rileyi* is here reduced to narrow marginal lines on the front and back edges connected by a moderately broad median line. Only a narrow portion at the base of the first antennal segment is yellow, and the yellow color on the coxae and trochantera of the typical form is here replaced by reddish-ochreaceous. There is a small yellow or orange spot on each side of the mesothorax, just above the coxae. The mesonotum is yellow, with a brown transverse band across the anterior edge from which two obsolescent brown bands extended backward, diverging posteriorly, but not reaching the metasternal suture; these diverging bands vary considerably in intensity in different specimens. The abdomen is slightly more narrowed behind than in typical *rileyi*, but the structure of the antennae and the hind legs of the males is the same in both forms.

In my collection I have Michigan specimens of *Metrobates hesperius* Uhler and *Trepobates pictus* (Herrich-Schaeffer), two halobatine species which are widely distributed in North America, and they may possibly occur in this vicinity. *T. pictus* is lacustrine in habits, and is found both on the open water of large lakes and on sheltered coves; and *M. hesperius*, while usually found in the same situations as that species, is also found occasionally on slow-flowing rivers.

FAMILY VELIIDAE, THE BROAD-SHOULDERED WATER-STRIDERS.

Key to the Genera of Veliidae of the Douglas Lake Region

Fourth antennal segment longest; last segment of middle tarsi deeply cleft, the cleft set with feathery hairs; hind femora incrassate and spinose ....RHAGOVELIA
First antennal segment longest ....MICROVELIA

GENUS RHAGOVELIA MAYR

7. *Rhagovelia obesa* Uhler. Apparently rather rare here. The only specimens taken within our limits were collected on Maple River in August, 1914. Miss Butler secured about half a dozen specimens on August 3, 1918, on a small stream about fifteen miles west of Mackinaw City, in Emmett County, where they were found in company with *Gerris remigis*.

GENUS MICROVELIA WESTWOOD

8. *Microvelia borealis* Bueno. Common. This species was most abundant at Bryant's Bog (Sta. IX), under the overhanging Chamaedaphne around the margins of the pond. At

several of the other stations it was found among the emergent vegetation, running about on the surface of the water. A single winged specimen was taken.

FAMILY MESOVELIIDAE

A single species occurs in Michigan.

GENUS MESOVELIA MULSANT AND REY

9. *Mesovelia mulsanti* B. White. Abundant on the weed-grown pools and ponds in the Douglas Lake region, and especially at home around the floating leaves of the Potamogetons and water-lilies. All the specimens secured were apterous.

FAMILY SALDIDAE, THE SHORE-BUGS

Key to the Genera of Saldidae of the Douglas Lake Region

Pronotum conical, much narrowed anteriorly, lateral margins straight .... SALDA
Pronotum not conical, less narrowed in front, lateral margins strongly arcuate ....SALDULA

GENUS SALDA FABRICIUS

10. *Salda coriacea* Uhler. Rare in this region. Two specimens were taken with the next species by sweeping sedges near the open water at Smith's Bog (Sta. XII) on July 29, 1918.

GENUS SALDULA VAN DUZEE

11. *Saldula pallipes* (Fabricius). This shore-bug was found fairly commonly among the scanty vegetation along the east beach of the lake (Sta. II), and along the sandy flats beside Maple River (Sta. VIII). It was also taken occasionally by sweeping the bulrushes and sedges at several of the beach pools; but by far the largest single catch of this species (27 specimens) was made at Station XII on July 29, both by

sweeping the sedges and by picking the insects from the surface of the water, where they had probably been driven from the Carex by the strong wind which was blowing at the time.

Family Notonectidae, the Back-swimmers

Key to the Genera of Notonectidae of the Douglas Lake Region

1. Hind tibiae and tarsi not ciliated; abdomen not keeled; body about twice as long as wide, roundly convex above; length less than 3 mm. .... Plea
   Hind tibiae and tarsi ciliated; abdomen keeled and hairy; body two and one-half to three times as long as wide, much less convex above; length 5 mm. or more 2
2. Fourth antennal segment much longer than third; hind tarsi with minute claws; length less than 8 mm., shape slender. Buenoa
   Fourth antennal segment much shorter than third; hind tarsi without claws; length more than 8 mm., shape more robust .... Notonecta

Genus Notonecta Linnaeus

In the following key to the species of Notonecta the term vertex means the anterior edge of the head between the eyes as seen from above, and the term synthlipsis is applied to the place on the dorsal side of the head, near the hind margin of the eyes, where the interocular distance is a minimum.

Key to the Species of Notonecta in the Douglas Lake Region

1. Inner margins of the eyes not greatly diverging, vertex not more than one and one-half times as wide as synthlipsis; length about 14 mm., coloration variable.......... *N. insulata*
   Inner margins of eyes more widely divergent, vertex at least twice as wide as synthlipsis 2
2. Vertex two to two and one-half times as synthlipsis 3
   Vertex three times as wide as synthlipsis 4
3. Larger species, length 12½-14 mm.; body more robust, length about 2.7 times width of pronotum; color luteous, scutellum nearly concolorous with hemelytra, which are rarely marked with dark except for a short narrow marginal vitta at base of costal area.................... *N. borealis*

Smaller species, length 10-12½ mm.; body more slender, length about three times width of pronotum; scutellum usually with a large black area, hemelytra usually with a black fascia at apex of corium....................*N. undulata*

4. Small slender species, length about 9 mm.; color usually white, without dark markings ....*N. variabilis*

Large robust species, length 13 to 15 mm.; color of hemelytra bluish-black, irrorated with castaneous ....*N. irrorata*

12. *Notonecta irrorata* Uhler. This beautiful species seems to have been fairly common in 1913, especially in the calm slow-flowing waters of Bessey Creek, where a number of specimens were secured; but in each of the other years only four individuals were taken.

13. *Notonecta variabilis* Fieber. Locally abundant, especially in the lower portion of Bessey Creek (Sta. VII), where sixty-three of the sixty-seven specimens were secured. This species was found only among the vegetation, and was rarely seen at the surface of the water: by far the greater number of the specimens were taken by dredging among the Potamogeton and Ceratophyllum at the edges of the stream. It was much more abundant during August than in July.

14. *Notonecta borealis* Bueno and Hussey. This is the species which Mr. Bueno reported in 1904 from British Columbia as *Notonecta lutea* Müller, but a study of the genitalia shows it to be very distinct from that species. A description of it as a new species by Mr. Bueno and the writer will appear shortly. Mr. Van Duzee, in his Catalogue of the Hemiptera of America North of Mexico reports it also from Manitoba, and I have seen one specimen from Maine in Prof Parshley's collection. This is the first published record for the United States.

In the Douglas Lake region, though rather restricted in its local distribution, it ranks next to *N. undulata* in abundance, and at Bryant's Bog (Sta. IX), far outnumbers that species. It is particularly abundant in the peat bogs, though found also in small numbers in the larger beach pools which have a considerable area free from emergent vegetation. Miss Miller reported thirteen specimens from North Fishtail Bay (Sta. IV), on July 26, 1913, but no others were taken there either in that year or in the other years.

Except for five specimens taken at Station XII on July 5, this species was never found in emergent vegetation or in shallow water. It was commonly seen floating at the surface of open water, ready to dive at any time; and it is the wariest Notonecta of my acquaintance. This was the only species of the genus of which imagoes were found early in July at Douglas Lake.

15. *Notonecta undulata* Say. The most abundant and widely distributed back-swimmer in the Douglas Lake region, common in all the quiet-water habitats except Bessey Creek. Like the last species, *N. undulata* was seldom found among the vegetation in the larger pools, but was most often observed floating at the surface in the open water, a few feet outside the plant zone. Like most of the other species of the family, *undulata* was much more abundant in the later part of the summer than early in July, imagoes being found only occasionally before about July 20.

About five percent of the specimens lacked the black fascia at the apex of the corium, and in one specimen there was no trace of black on the scutellum.

16. *Notonecta insulata* Kirby. One of the least common species of the genus in this vicinity. No specimens were secured either in 1913 or in 1914; and in 1918 only seven specimens were taken, at Stations IX and XII.

Genus Buenoa Kirkaldy

The various species of this genus with which I am acquainted in life appear to have a very nicely adjusted mechanism for maintaining their position at any level in the water without effort, and for regulating the interchange of gases between the bubble which they carry with them and the supply dissolved in the water. This promises to be a very interesting problem for future investigation.

Key to the Species of Buenoa of the Douglas Lake Region

Eyes strongly projecting laterally beyond the pronotum; head with eyes wider than body at its widest point; form more slender; membrane without a black transverse spot at base .... *B. platycnemis*

Eyes not strongly projecting; head with eyes much narrower than widest part of body; form more robust; membrane most commonly with a large black transverse spot outside near base .... *B. elegans*

17. *Buenoa platycnemis* (Fieber). Found in the same localities as *B. elegans,* but much less common, less than a dozen specimens being secured in 1918. My determination of this species has not been verified, as through an oversight no specimens were sent to Mr. Torre-Bueno.

18. *Buenoa elegans* (Fieber). Abundant in the peat bogs, and also found occasionally in the larger beach pool at Sedge Point. The adults were found only in the open water, and were commonly seen swimming at some little distance below the surface; but on several occasions nymphs of a Buenoa were found among the emergent vegetation in shallow water at Sedge Pool.

A third species of Buenoa, *B. margaritacea* Bueno, may possibly occur in this region also. It was described from New York, and has subsequently been reported from Florida, Illinois, and Kansas, and I have seen specimens from California and have found it very common in the vicinity of Minneapolis and St. Paul, Minnesota. It may readily be distinguished from either of the preceding species by its shorter hemelytral commisure, which is distinctly shorter than the pronotum and scutellum combined, while in *B. platycnemis* and *B. elegans,* as represented in my collection, the commisure is from one-third to one-half longer than the combined length of the pronotum and the scutellum.

GENUS PLEA LEACH

19. *Plea striola* Fieber. Rather uncommon during July among the emergent and submerged vegetation of Sedge Pool.

FAMILY NEPIDAE, THE WATER SCORPIONS

This family is represented here by a single genus and two species.

GENUS RANATRA FABRICIUS

Juga parallel, their apices somewhat prominent; tylus distinctly longer than juga .... *R. americana*

Juga converging anteriorly, almost touching the tylus in front; tylus slightly longer than juga .... *R. protensa*

20. *Ranata americana* Montandon. Common in all the beach pools, and found occasionally also at Stations IV, IX, and XII, during the later part of July and all of August. In the beach pools the species occurred in the emergent vegetation, and in the larger and more open bodies of water it was found under the thickly vegetated overhanging banks. Nymphs of water scorpions were found abundantly after July 10, and eggs were found imbedded in decaying bulrush stems at Station VI on July 26 and August 19.

The Douglas Lake specimens vary considerably in size and in the prominence of the subapical notch of the front femora, which in the majority of the individuals is quite distinct, in others obsolete, and in a few wanting entirely.

21. *Ranata protensa* Montandon. Mr. Torre-Bueno has identified two of the specimens sent to him as this species.

The key given above is based on Montandon's original descriptions (Bull. Soc. Sci. Bucarest, xviii, p. 185, and xix, p. 66, 1910).

FAMILY BELOSTOMATIDAE, THE GIANT WATER-BUGS

Three species of this family, belonging to two genera, have been taken here, and another may occur.

Key to the Genera of Belostomatidae of the Douglas Lake Region

Head not conically produced before eyes; "furrow" of membrane of hemelytra sinuate; size larger, length 40 mm. or more ....LETHOCERUS

Head conically produced before eyes; "furrow" of membrane straight; smaller, length less than 25 mm. ....BELOSTOMA

GENUS LETHOCERUS MAYR

22. *Lethocerus americanus* (Leidy). Not at all common, only five adults having been secured in two seasons' collecting, and none being reported for 1914. All the mature forms were taken from the largest beach pool at Sedge Point (Sta. VI), both by dredging in the mud and by running nets through the vegetation. A single exuvium of a late nymphal instar was found at Station XII on July 29, and nymphs of a Lethocerus were fairly numerous in one of the pools at Station III before this pool dried up.

A specimen taken on the beach at Station I on July 4 was determined by Mr. Torre-Bueno as *Lethocerus obscurus* (Dufour), but I must confess my inability to distinguish it from *L. americanus.* It is fully as large as several of the Douglas Lake specimens of that species, measuring 49 by 18 mm., and the structure of the head does not appear to be different.

23. *Lethocerus* sp. Two specimens of a Lethocerus much larger than *americanus*, measuring 58 mm. and 61 mm. respectively, were taken at Station VI on August 7 and August

10, 1918. The smaller one especially is very distinct from *americanus,* and this appears to be an undescribed species, but more material is needed to decide its status definitely. Mr. Torre-Bueno writes me, "The large Lethocerus is one that I have received from the west—Oregon, Washington, etc."

GENUS BELOSTOMA LATREILLE

24. *Belostoma flumineum* Say. Common all summer in all the pools and bogs where there was submerged or emergent vegetation growing in shallow water. Males which were carrying eggs were often seen in July.

FAMILY CORIXIDAE, THE WATER BOATMEN

Representatives of two genera of this family have been found at Douglas Lake. The following key will serve to distinguish them. The strigil in Arctocorixa is a small but distinct elongate or elliptical plate at the dextral margin of the antepenultimate tergite of the abdomen, and in our species at least, is directed longitudinally or obliquely.

Strigil absent; basal segment of hind tarsi with a large apical black spot	CALLICORIXA
Strigil present in males; basal segment of hind tarsi without an apical black spot, although sometimes fringed with black hairs	ARCTOCORIXA

GENUS CALLICORIXA B. WHITE

25. *Callicorixa* sp. Three specimens of a Callicorixa, probably *C. kollarii* (Feiber), were taken in the Maple River below Station VIII on August 17, 1914. No others have been collected in the region.

GENUS ARCTOCORIXA WALLENGREN

Several specimens of the 1913 collection were sent to Professor Abbott in that year, and he identified them as belonging to three species, *A. signata* (Fieber), *A. interrupta* (Say), and a new species to which he gave the name *A. nana*; but the entire collection was not determined. After examining the 1918 collection, I strongly suspect that several other species are represented in it, but I have not attempted to make any determinations in this very difficult group; and, as Professor Abbott is now in Japan, identification of these forms by a competent authority is not possible at present. Of *A. nana* Professor Abbott wrote in 1913, "It belongs to the *Arctocorixa interrupta* group, and is the smallest member of it that I have seen." No description of this species has been published as yet.

Arctocorixa interrupta is the most abundant water boatman in this vicinity, with *A. nana* second and *A. signata* third, the three species occurring in the 1918 collection roughly in the ratios 3:2:1 respectively. The other forms were relatively uncommon.

DISCUSSION

The general characteristics of the hemipterous fauna of this region can be summarized very briefly. As far as can be judged from the study of the limited area under consideration, the fauna of this part of Michigan is transitional between that of the north and north-west and that of southern Michigan—and the latter appears to be fairly typical for central North America. Careful collecting at Douglas Lake failed to show the presence of *Benacus griseus, Pelocoris femoratus, Ranata kirkaldyi,* or Gelastocoris, all of which are fairly common in the region about Ann Arbor; while *Plea striola,* which is very abundant at Ann Arbor, was found to be uncommon here. On the other hand, a few boreal species such as *Notonecta insulata* and *Gerris rufoscutellatus,* which occurred at Douglas Lake, are rare in the south-eastern part of Michigan. The presence of the large Lethocerus links the Douglas Lake region with the far north-west, and the absence of records for these species indicates the need for careful collecting in the intervening districts.

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AN UNDESCRIBED MICROHYLA

BY THOMAS BARBOUR

By a curious coincidence twice within a very short time problems have arisen with respect to Microhyla, a genus which, in general, seldom calls for comment in an American museum. Dr. Malcolm Smith of Bangkok sent me some examples of *M. pulchra* from Siam which enabled me to compare the types of *M. hainanensis* with this species. I found the two related but easily distinguishable. Just then Dr. A. G. Ruthven sent for study a small suite of amphibians from Nanking, China, and again Microhyla appeared. These specimens from China had been considered the same as the Indian *M. ornata* by Boulenger in 1882 (Cat. Batr. Sal. Brit. Mus., p. 165). So far as I am aware this allocation has not been reconsidered. That this little frog should have such a wide range seemed at once most improbable and my receipt since of an example of *ornata* taken in Pegu, from Dr. Boulenger, has enabled me to separate the forms. To be sure Duméril and Bibron (Erp. Gèn., 8, 1841, p. 745) expressly state that the types of *ornata* came from Malabar, India, collected by Dussumier, a long way from

Pegu, hence should the Burmese example prove not to be typical *ornata* it can only indicate the existence of yet another form, which is highly probable.

Butler and Flower have contributed notes often quoted by Boulenger, but in general little is known regarding the habits of Microhyla. In life they remind one of our southern Gastrophryne (Engystoma) but they fare abroad more freely and are vastly more active. I have taken two species, *achatina* and *annectens*. I imagine they were not uncommon on the floor of the high rain-forest about Tjibodas, Java. One large adult *achatina* I found squatting like a Hyla in the center of a large peltate leaf several feet above ground.

Many species of this genus have been described recently, the validity of which cannot now be determined. Vogt, in 1913, (Ges. Naturf. Freunde, Berlin, p. 223 *et seq.*), essayed a key to the genus and listed the species. The paper is marred by egregious errors in spelling, the list is incomplete and the key not entirely convincing.

The following species appear probably worthy of recognition:

Microhyla achatina (Boie), Isis, 1827, p. 294. Southeastern Asia, Sumatra and Java. Recorded from the Moluccas, which is beyond doubt erroneous.

Microhyla ornata (Duméril and Bibron), Erp. Gèn., 8, 1841, p. 745. India, Burma, Malay Peninsula.

Microhyla rubra (Jerdon), Jour. As. Soc. Bengal, 22, 1853, p. 534. India and Ceylon.

Microhyla pulchra (Hallowell), Proc. Acad. Nat. Sci. Phila., 1860, p. 506. Southern China and Siam.

Microhyla berdmorei (Blyth), Journ. As. Soc. Bengal, 24, 1855, p. 720. Burma, Siam, Malay Peninsula and Sumatra.

Microhyla fissipes Boulenger, Ann. Mag. N. H. (5), 13, 1884, p. 397. Formosa.

Microhyla inornata Boulenger, P. Z. S., 1890, p. 37. Burma, Siam, Malay Peninsula, Sumatra and Borneo.

Microhyla bungarana (Günther), Nov. Zool., 2, 1895, p. 501. Natuna Island.

Microhyla palmipes Boulenger, Ann. Mag. N. H., (6), 14, 1897, p. 108. Java.

Microhyla leucostigma Boulenger, Ann. Mag. N. H., (7), 3, 1899, p. 275, pl. 12, fig. 1. Malay Peninsula, Borneo.

Microhyla butleri Boulenger, Ann. Mag. N. H., (7), 6, 1900, p. 188. Perak and Tonkin.

Microhyla annectens Boulenger, Ann. Mag. N. H., (7), 6, 1900, p. 188. Malay Peninsula, Borneo and Java.

Microhyla okinavensis Stejneger, Proc. Biol. Soc. Wash., 14, 1901, p. 189. Riu Kiu Islands.

Microhyla picta Schenkel, Verh. Ges. Basle., 12, 1901, p. 151. ?Cochin-China (*pulchra?*).

Microhyla hainanensis Barbour, Bull. M. C. Z., 51, 1908, p. 322. Hainan.

Microhyla stejnegeri Boulenger, Ann. Mag. N. H., (8), 4, 1909, p. 494. Formosa.

Microhyla heymonsi Vogt, Sitzber., Ges. Naturf. Freunde, Berlin, 1911, p. 181. Formosa.

Microhyla boulengeri Vogt, Sitzber. Ges. Naturf. Freunde, Berlin, 1913, p. 222. Hainan.

To these there is to be added a new species here described.

Microhyla eremita, new species

Type Specimen: Museum Comparative Zoology, No. 5114, from Nanking, China, collected during the summer of 1918 by Cora D. Reeves. Paratype in Museum of Zoology, University of Michigan, No. 53103, Cora D. Reeves, collector.

Description: Similar to *M. ornata* from which it differs in having a larger eye, shorter snout, the distance from anterior border of eye to tip of snout in all specimens being a little less than the diameter of the eye, while in *ornata* the snout is longer than the orbital diameter (or fide Blgr.* sometimes equal to it). Coloration widely different, habit more robust.

Habit robust. Snout obtuse, less than orbital diameter; fingers slender, first much shorter than second; toes slender, first toe reaching to lower articular tubercle of second toe (not so in *ornata*); tips of fingers and toes not swollen (same in Pegu example); sub-articular tubercle prominent; two small subequal metatarsal tubercles. The hind limb being carried forward along the body the tarso-metatarsal articulation reaches the anterior border of the eye. Skin smooth. Back with a faint inverted Y-shaped marking, a dark band along each side very faintly indicated. Legs with faintly indicated cross bars. No markings conspicuously prominent.

Remarks: In coloration the small suite of Chinese examples is singularly uniform and all differ very conspicuously from the Pegu specimen in which the dark lateral zone is sharply defined along its entire upper margin and furthermore is accentuated by a row of distinct elongate black dots which appear to be associated with tiny dermal folds or excrescences which may be due in part to the preservation. The line nevertheless commences upon the snout, is continued across the upper eyelid, then along the whole side of the groin. This feature with the longer snout and the different habit and differently proportioned feet separate *ornata* from *eremita*, which moreover is undoubtedly entirely confined to a temperate instead of a tropical habitat.

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* Here, as is so often the case, it is extremely unfortunate that a single specimen is not described and accurately specified. The description is drawn in general terms probably or possibly from both Indian and Chinese examples and must perforce include the peculiarities of specimens from these scattered regions. Boulenger among others (Cat. Batr. Sal., 1882, p. 165) had specimens from Ningpo, China, Cambodia and Madras before him.

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RESULTS OF THE UNIVERSITY OF MICHIGAN-WILLIAMSON EXPEDITION TO COLOMBIA 1916-1917[1]

V. NOTES ON A FEW SPECIES OF PROGOMPHUS (ODONATA)[2]

BY E. B. WILLIAMSON

The following notes deal with specimens of Progomphus collected by me in Guatemala in 1909, and by J. H. Williamson and myself in Colombia in 1916. A new species from Guatemala is described.

With the new species of Progomphus described in this paper, twenty-three species of the genus are now known. Kirby lists eleven species in his Catalogue. The elevation of *borealis* to its proper specific rank makes the number twelve. In the Bio. Cent. Amer., p. 150, Calvert describes *P. clendoni,* and in

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[1] A Collecting Trip to Colombia, South America, Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 3, February, 1918.

[2] I, Occ. Papers, Mus. of Zool., Univ. of Mich., No. 52, April 17, 1918. II, *ibid.*, No. 59, June 24, 1918. III, *ibid.*, No. 63 January 5, 1919. IV, *ibid.*, No 68, April 24, 1919.

Od. Neotrop. Reg., Ann. Carn. Mus., he describes *P. recticarinatus.* Ris, Beit. zur Odonatenfauna von Argentina, Deutsch. Ent. Zeitschr., 1908, describes *P. joergenseni;* in Ueber Einege Gomphinen von Sudbrasilien und Argentina, Mem. Soc. Ent. Belg., XIX, 1911, he describes *P. auropictus, lepidus,* and *basisticus;* and in Libellen (Odonata) aus der Region der amerikanischen Kordilleren von Costarica bis Catamarca, Archiv fur Naturgeschichte, 1916, he describes *longistigma, phyllochromus,* and *perpusillus.*

The twenty-three species of the genus Progomphus, while forming a natural and generally easily recognized group, yet show remarkable differences in several characters. Venational differences involving characters generally considered valid for the definition of major groups exist within the genus (crossed or open triangles). In Plate II the wings of three species are shown: in *pygmaeus,* fig. 5, the triangle of the front wing is open and the anal field is only one cell wide, and in the hind wing there are three postanal cells in both the proximal and distal rows; in *risi,* fig. 6, the anal field in the front wing is two cells wide for a short distance both proximal and distal to the level of the triangle, and in the proximal row of postanal cells in the hind wing there are four cells, and three in the distal; in the unnamed species, fig. 7, the anal field of the front wing is still wider, and in the hind wing there are four cells in both the proximal and distal rows of postanal cells. The change in form of the triangle from a fairly regular three-sided figure to almost a four-sided figure, due to the angling of the distal side of the triangle, may be traced in figures 5 to 7.

In the proportion of the tibia and tarsus of the third pair of legs striking differences exist. The difference between *risi* and *pygmaeus* is discussed below in the description of *risi.* In *joergenseni* the third tibia and tarsus bear the same relation to each other as in *pygmaeus.* Generally the third tibia and the tarsus without the claws are approximately equal or the tibia is slightly the longer, but I lack sufficient material to study the matter in detail. In *risi,* however, the hind tarsus without claws is slightly longer than the tibia.

Under the discussion of *risi* I also call attention to the great difference in the length of occipital hairs in *risi* and *pygmaeus.* The more robust build of *risi* as compared with *pygmaeus* is also conspicuous. Within the genus considerable differences in thoracic color patterns exist. Figures 1-3, Plate I, illustrate this.

Progomphus risi, new species

Figs. 1, 6, 8, 9, 10, 11

Description: Abdomen, male 26, female 26.5; hind wing, male 18, female 21.5.

Male.—Rear of head brown, paler below, mouth parts light brown; face brown, marked with leaden or bluish gray as follows: a spot below, not touching the borders, on either side of the labrum; rhinarium entirely pale; nasus with a spot on either side, reaching the extreme lateral border; and frons in front above the last yellowish or greenish. Frons above pale, greenish or yellowish, a median posterior ill-defined triangular leaden colored area; vertex and antennae black or dark brown; ocellary ridge, posterior to each lateal ocellus, well-defined, curved, not angled, at its outer end between the ocellus and the eye; the two postocellary ridges, one posterior to each lateral ocellus, meeting in the median line almost in a straight line, the angle between them very obtuse; occiput dark dull green, the posterior edge and adjoining the eyes darker, indentate in the median line from which it rises, on either side, in a very slight concavity to the rear of the head; hairs on posterior edge relatively weak and short, shorter than the occiput is long (distance from frons to posterior border of the occiput about midway between the angle of the eye and the median line).

Prothorax black with some indefinite small yellow markings; middle lobe with the posterior, inflated-like, transverse area on either side entirely bluish gray.

Dorsum of thorax rich brown to almost black with a pale almost white stripe on either side, the inferior end of which is more or less bluish gray; these two dorsal pale stripes widely divergent; no trace of a mesothoracic collar; side of thorax lighter brown and bluish gray. Coxae light brown in front indefinitely marked with paler, behind pale bluish gray; under parts bluish gray, passing to light brown posteriorly.

Abdomen robust, seen from above largely dark brown or black; 1 brown at base, black apically; 2 narrowly brown at base, followed by a transverse bluish gray band extending to and covering the auricles above, posterior half of segment brown; 3-5 black, each with a basal triangular bluish gray spot, narrowly separated from the base, pointed posteriorly, extending three-fourths the length of 3, less than half the length of 4, and about one-fourth the length of 5; 6 and 7 black; 7 with the basal two-sevenths or one-third dull yellow, the pale color continued indefinitely posteriorly in a thread-like dorsal line; 8 black or nearly so; 9 and 10 dark brown. Seen from the side the inferior third of 1 is bluish gray; 2 is brown with the inferior posterior portion bluish gray; 3 is brown, shading to black apically with a small obscure inferior basal bluish gray spot; the remaining segments are black with the basal pale ring of 7 carried to the inferior margin. Sterna of segments 3-5 ending apically in a small narrow spine-like projection. No ventral spine or tubercle on 1. Superior appendages jet black at base, the apex light yellow, the black oblique, occupying about one-fourth the length above and about one-half the length below; inferior appendage brown.

Wings hyaline, no trace of any colored areas, very faintly greenish tinged to the nodus; costa brown, narrowly and inconspicuously edged with pale greenish or yellowish blue. Stigma dark brown, covering 4 to 4.5 cells in the front wing and 5 to 5.5 in the hind wing; in one hind wing the cells posterior to the stigma are abnormal. Antenodals front wing 11 or 12, hind wing 7 to 9; postnodals front wing 5 to 8, hind wing 6 or 7; basal antenodal of second series present; the distal thickened antenodal the fifth. Triangle of front wing once crossed; of hind wing free in one wing, once crossed in three wings, the single uncrossed wing is abnormal in that the anterior side of the triangle, instead of meeting M_4 at or slightly proximal to the distal anterior angle of the triangle, meets the distal side of the triangle posteriorly to the distal anterior angle a distance about equal to half the length of the arculus; the anterior side of the triangle in this abnormal wing therefore occupies a position about midway between the anterior side of the triangle and the cross-vein of the triangle in the normal wing, and takes the place of the two. The subtriangle is once crossed in all front wings and free in all hind wings. Anal field of the front wing proximal to the triangle two cells wide for a distance of two cells, counting the anterior row; distal to the triangle the field is two cells wide for a distance of three or four cells. There are four cells in the proximal row of postanal cells and three or four, usually three, in the distal row.

Legs short, femora reddish brown, shading into black at apices, the first pair bluish gray beneath; tibiae and tarsi black; tarsal claws dark reddish brown, the teeth and apices black.

Hind tibiae relatively short, shorter than the hind tarsi without the claws.

Female.—More robust than the male; the head about 6 mm. wide (5 in the male) and paler colored; the labrum is largely light yellowish brown, and the brown on nasus and frons below in front is paler and duller, less sharply contrasted with the adjacent bluish gray parts, and, on the nasus, reduced in extent. Vertex yellowish brown, the ocellary ridges lighter in color; occiput similar to that of the male, slightly paler.

Prothorax patterned as in the male with yellowish brown replacing the black of the latter.

Thorax light reddish brown, little if any darker on the dorsum, marked with bluish gray with the same pattern as in the male, except that there is a faint trace of pale color on either side on the dorsum just in front of the antealar sinus; under parts and coxae slightly paler than in the male.

Abdomen robust, colors and pattern obscure and ill-defined, probably due to postmortem changes; 1 largely pale, apical half or less of dorsum and an ill-defined median lateral spot brown; 2 largely pale, with no defined pattern, but apparently much faded so colors in life cannot be described; 3-5 apparently as in the male, with the dorsal basal pale areas more extensive, extending apically about one-half the length of each segment on 4 and 5; 6 black; 7 light brown, without trace of pattern in the dried specimen; 8-10 indefinitely patterned black and brown, black predominating. Sterna of segments 2-5 ending apically in a small spine-like projection. No trace of ventral spine or tubercle on 1. Appendages yellow, brown at the extreme base.

Wings hyaline, no trace of colored areas, slightly greenish tinged to or beyond the nodus especially in the anterior part of the wings; costa brown. Stigma brown, covering 4 to 4.5 cells in the front wing and 4 to nearly 5 in the hind wing. Antenodals front wing 12, hind wing 8 or 9; postnodals front wing 7, hind wing 7 or 8, basal antenodal of second series present; the distal thickened antenodal the fifth. Subtriangle in hind wing free, all other triangles and subtriangles once crossed. Anal fields as in the male.

Legs as in the male, slightly paler in color.

Material Studied: Gualan, Department Zacapa, Guatemala, June 16, 1909, two males and one female, one male and the female the type and allotype respectively, in coll. E. B. W. Named for Dr. F. Ris, whose many acts of personal kindness, as well as his valuable contributions to Odonatology, are gratefully acknowledged by the author. A male and female of this species, same locality and date, not studied in the preparation of this paper, are in Dr. Calvert's collection. These specimens and specimens of *P. pygmaeus* from Colombia, sent to Dr. Calvert by me, have been carefully studied by Dr. Calvert and compared with de Sely's original description of *pygmaeus* and with specimens of that species from Costa Rica in his collection. His notes on all this material have been placed at my disposal. His conclusion is that the Gualan species, here described as *risi,* is new and distinct. Drawings of the abdominal appendages of *risi* were sent to Dr. Ris who also pronounced the species new.

Remarks: *Progomphus risi,* next to *P. pygmaeus* and *perpusillus,* is the smallest species of the genus. From *pygmaeus* it is separated in both sexes by the following venational differences: anal field in front wing one cell wide throughout in *pygmaeus,* two cells wide for short distances both proximal and distal to the level of the triangle in *risi;* three cells in the proximal row of postanal cells in the hind wing in *pygmaeus,* four cells in *risi.* In both sexes of *pygmaeus* the legs, especially the third pair are relatively longer and slenderer and the hind tarsus without the claws is only about two-thirds as long as the hind tibia, while in *risi* the hind tarsus without the claws is actually longer than the shortened hind tibia, giving the leg a malformed appearance. In *pygmaeus* the occipital hairs are fully one-half longer than in *risi* (*pygmaeus* .35-.40 mm., *risi* about .25 mm.), while the relative difference is greater, as the occiput of *risi* is about one-half longer (measured from frons to posterior border of occiput about midway between the angle of the eye and the median line) than *pygmaeus*. The thoracic patterns of the two species are very different (see figs. 1 and 2); and the male appendages and female vulvar laminae are equally distinct (compare figs. plate III). *Perpusillus* is the smallest gomphine known, with abdomen only 18 mm. long and hind wing 15 mm. long. It and *longistigma*, which is very slightly larger than *risi*, differ from *risi* in both thoracic color patterns and abdominal appendages. From *P. gracilis*, which it approaches in size, *risi* may be recognized by the presence of the basal antenodal of the second series, which is wanting in *gracilis*, and by the very different thoracic pattern (see figs. 7 and 8, Ueber Gomphinen von Sudbrasilien und Argentina, Mem. Soc. Ent. Belg., XIX, 1911, Dr. F. Ris). In the key in Dr. Ris's paper referred to in the preceding sentence, *risi* will not go in either of his two groups A and B, being separated from A by the presence of the basal antenodal of the second series, and from B by the small number of two-celled rows of cells proximal to the triangle in the anal field of the front wing.

The small species, *P. lepidus*, belongs in Ris's group A, and it is separated from *risi*, in addition to the venational difference, by the very different thoracic pattern and male abdominal appendages (see Ris's figs. 9 and 10). In Calvert's key to the Central American species of Progomphus (Bio. Cent. Am.), two groups based on the presence or absence of a sternal process or tubercle on abdominal segment 1 are recognized. *Pygmaeus* is the only species in the key lacking this process, which is also lacking in *risi*. Differences between the two species have been indicated above.

A short distance above the railway station at Gualan, Guatemala, the railroad crosses the Gualan River. Just above the bridge a small stream from the right enters the Gualan River. Much collecting was done along this small stream in January, 1905, but no gomphines were seen. In June, 1909, however, there were two handsome species of Gomphoides and *Progomphus risi*. A short distance above the mouth of the small stream was a pool, shallow on one side and with a wall of vegetation on the opposite deeper side. The three species of gomphines were accustomed to fly in to this sunny pool and alight on leaves overhanging the deeper water.

Progomphus pygmaeus Selys

Figs. 2, 4, 5, 12, 13, 14

Description: Abdomen, male 23-25, female 22.5-23.5; hind wing, male 19, female 20.

Face brown, marked with gray as follows: lower part of labrum, variable in extent, rhinarium entirely, and frons above. Rear of head indefinitely mottled green and brown, variable, darker above, below varying from almost entirely green to almost entirely brown. Thorax brown, marked with greenish; dorsal thoracic stripes wide.

Legs brown to black and green or yellowish green; the first and second femora pale at base, above passing at once into brown which passes into black; below pale; third femora largely pale, the apical fourth or fifth brown above, the extreme apex black, unusually long and slender for the genus; tibiae and tarsi black; third tibia longer than the tarsus and claws. The Chapada female, discussed below, has the legs incomplete but apparently similar.

Wings hyaline to more rarely smoky tinged especially about the nervules, no trace of any distinct colored area. Costa dark. The venational characters of 25 male wings and 6 female wings were tabulated with the following result: triangle front wing free, 16% male, 0% female; crossed 84% male, 100% female: subtriangle front wing crossed, 100% male, 100% female; triangle hind wing crossed, 100% male, 100% female: subtriangle hind wing free, 32% male, 0% female; crossed, 68% male, 100% female: anal field front wing one cell wide, 100% male, 100% female: three postanal cells in the proximal row, 100% male, 100% female: two postanal cells in the distal row, 68% male, 33 1/3% female; three in the distal row, 32% male, 66 2/3% female.

Male.—Abdominal segment 2 with a narrow longitudinal dorsal pale greenish stripe the length of the segment, separated from the extensive pale lateral areas; 3 similarly patterned, the dorsal stripe becoming very narrow apically but reaching nearly or quite to the apex, and the lateral pale area confined to the basal third of the segment; on 4 the apical extension of the dorsal stripe and the lateral area is still more reduced, the areas joining more or less basally to form a ring, and the thread-like extension of the dorsal stripe extending about four-fifths the length of the segment or less; on 5 and 6 the dorsal pale stripe is not evident, but the basal lateral areas are nearly or quite united in the mid-dorsal line to form a narrow transverse basal ring on each segment; 7-10 and appendages as described by de Selys, the basal ring on 7 apparently greenish, the lateral stripe on 8 yellowish and really better described as two spots more or less obscurely joined; these two spots on 8 are also present on 7 as a triangular spot just posterior to the basal greenish area with the apex of the spot directed posteriorly and an apical, less definitely triangular spot with its apex directed anteriorly; the homologues of these two spots on 7 form the "bande laterale au 8^{e}" of de Selys.

Female.—Through the kindness of Mr. Kahl I have had for study the material in the Carnegie Museum determined by Dr. Calvert as *pygmaeus* (Bio. Cent. Amer.). The female from Chapada, Brazil, lacking the last seven abdominal segments, which served as the basis for the description of that sex of *pygmaeus* by Dr. Calvert, is really another and unnamed species, so that the female of *pygmaeus* has not hitherto been known. In *pygmaeus* the brown of the face is much lighter than in the Chapada species; in the Chapada female the frons is distinctly angled, the angle being the dividing line between the anterior brown and the dorsal green, in *pygmaeus* the frons is rounded and low, without a trace of an angle; in the same way the vertex is more flattened in *pygmaeus,* the postocellary ridge less prominent, and not developed into a more or less median over-hanging plate as in the Chapada female. In the Chapada female the occiput is straight, as described by Calvert, while in *pygmaeus* it is slightly concave, with a small median indentation. In the Chapada female the dorsum of the thorax is distinctly darker than the brown dorsum of *pygmaeus* and might be described as black; in *pygmaeus* the pale dorsal stripes are as shown for the male (fig. 2) or they may narrow continuously dorsally without any expansion or enlargement at the dorsal end, but in either case they are barely separated from the antealar sinus; in the Chapada female, on the other hand, the dorsal stripes are more yellowish and are much shortened, being separated from the antealar sinus by a distance about equal to their width at midlength; in addition there is in the Chapada female a dorsal antehumeral pale spot, no trace of which exists in *pygmaeus;* laterally *pygmaeus* is the paler, the obscure stripes on the sutures in the males of *pygmaeus* and the Chapada female, being more obscure or absent.

Abdomen brown, shading out to black on the apical segments, faded in dried material, apparently very similar to the male, but the lateral markings on 8 and the homologous markings on 7 not discernible; appendages pale (greenish yellow?), dark at the extreme base.

Material Examined: Bolivar, near Santa Marta, Colombia, December 24 and 25, 1916, 27 males, 3 females, collected by J. H. and E. B. Williamson, in Coll. E. B. W. (3 additional males, same locality and date have been sent to Drs. Calvert and Ris, and Mr. Campion); Bonda, Colombia, one imperfect male, H. H. Smith, collector, cited by Calvert (Bio. Centr. Amer.); the very teneral condition of this specimen explains Dr. Calvert's description of the color of the head. The locality where specimens were collected by J. H. Williamson and myself is briefly described on page 8, A Collecting Trip to Colombia, South America, Misc. Publ. No. 3, Univ. of Mich., Mus. of Zoology, but the number of specimens captured is there stated to be about 25, while the correct number is 33. I think every specimen seen was captured. We spent practically the entire day of December 25 looking for this one species with the result that we caught 25 specimens that day. They were always found resting on broad leaves at a slight elevation, usually a foot or two from the ground, and in the sun. *Pygmaeus* is a dull colored and, under the conditions we observed it, a sluggish species.

The Identity of P. pygmaeus Selys.—Specimens of the species taken near Bolivar, Colombia, were sent to Drs. Calvert and Ris, who independently identified them as *pygmaeus*. Unfortunately Mr. Campion was not able to compare the Colombian specimen sent him with the type of *pygmaeus* in the MacLachlan collection. This type came from Bogota, which means little in this connection as a definite locality. The existence of another very similar but distinct species at Chapada, Brazil, to which the description of de Selys is in some respects more applicable than to the Central American and northern coastal Colombian species throws doubt on the identity of these northern specimens. Moreover, in the Carnegie Museum there is another female Progomphus from Chapada of similar size, lacking the entire abdomen, but having the anal area distal to the triangle two cells wide or more. We are therefore sure that at least three small species of *Progomphus* exist, and that only one name is available. It seems to me very probable that other species will be found and that one of these, at present not known, or, less likely, the Chapada female, described by Calvert, and compared above with the Bolivar specimens, will be found to be the true *pygmaeus,* and that the Central American and northern Colombian species will be found to require a new name. Comparison of material I have sent to Mr. Campion with the de Selys type in MacLachlan's collection will settle this matter. Until that time it is well to bear in mind that at the time de Selys described *pygmaeus* he knew certainly six or seven more species of the genus, and he said "*pygmaeus* is very distinct by the distal side of the triangle of the front wing more angled than in any other species." The remarkable thing about the triangle of the front wing in the specimens from Bolivar, Colombia, is the short anterior side of the triangle. The distal side is not unusually angled. De Selys also speaks of the distal side of the triangle of the hind wing being strongly angled. *Pygmaeus* is described as having the thorax black, a matter in which de Selys could hardly be mistaken because of postmortem changes, yet the Bolivar specimens, fully matured, are brown. And the basal abdominal markings present on segments 3-6 in the Bolivar specimens are not mentioned by de Selys, though these may have been lost due to postmortem changes in the single specimen he had.

Progomphus clendoni Calvert

This species has been known from Tuxpan, Mexico (two males—Bio. Cent. Amer.), and from Costa Rica (Calvert, A Year of Costa Rican Natural History, page 429), so its occurrence in Guatemala is not surprising. But its distribution in Guatemala and the variation shown in the material collected are surprising. I took specimens at Puerto Barrios at approximately sea level; at Los Amates, at an elevation of 160 feet; in the mountains at Aqua Caliente and still higher at El Fiscal at an elevation of 3,700 feet, both towns in the Dept. Guatemala. El Fiscal is near the continental divide but is on the Atlantic side. But when the divide was crossed and collecting was done at Amatitlan, at an elevation of about 4,000 feet on the Pacific slope, *clendoni* was found there too. I can not explain my failure to find the species at Gualan, between Los Amates and Agua Caliente, where I collected carefully. The dates of captures run from May 28 to June 19, 1909, and altogether 13 males were taken.

In size the Guatemalan material varies from 35 to 41 in length of abdomen and from 27 to 30 in length of hind wing. The size seems to vary independently of locality though more material might show that averages varied for widely separated localities, having very different altitudes. This is indcated by the fact that the largest specmen is from El Fiscal in the mountains, but a second specimen taken there has the abdomen 37, while the smallest specimen is from Puerto Barrios at sea level.

In coloration two distinct groups are recognizable in the material: group 1, specimens from Aqua Caliente and El Fiscal; group 2, specimens from Puerto Barrios, Los Amates and Amatitlan. Group 1 most nearly resembles the type material from Tuxpan, Mexico. In this group the face markings are pale and not well defined; pale dorsal thoracic stripes separated in every case from the pale mesothoracic margin; pale antehumeral stripe barely or not separated to form a superior spot and an inferior stripe; wide pale stripe on mesepimeron continuous; wide pale stripe on metepisternum narrowly or scarcely divided to form a superior spot and an inferior stripe; metepimeron with the posterior inferior half or slightly more, pale; abdominal segment, 1 broadly pale below on the sides; 2 with a longitudinal pale dorsal stripe the full length of the dorsum, the auricle, a spot behind it and the inferior posterior margin of the segment conspicuously pale; 3 with a relatively broad longitudinal pale dorsal stripe from the base to the apical spines, and with the inferior lateral margin broadly pale; on 4 the dorsal stripe extends from the base about four-fifths the length of the segment, and on 5 about three-fourths; on 6 this stripe is a little more than half the length of the segment, dilated at the base to form a transverse band, as on segments 4 and 5, and again equally dilated just anterior to the transverse carina to form a second transverse band; 7 entirely yellow at base, except the extreme lower border, to the transverse carina, with a dorsal prolongation of yellow about two-fifths across the apical black, and with the lower margin, posterior to the transverse carina, broadly yellow; lower half of 8-10, in side view, obscurely pattened in yellow or yellowish brown; basal black on dorsum of appendages reaching the level of the externo-lateral dilatation of the appendages.

In specimens of group 2 the colors are as follows: face markings dark brown, conspicuous and well defined; pale dorsal thoracic stripes very slightly narrower than in group 1, widely separated from the pale mesothoracic collar, which is more widely divided in the median line than it is in group 1; pale antehumeral narrowly to widely separated above to form a superior spot and an inferior stripe; pale stripe on mesepimeron narrower than in group 1, and separated to form a superior and inferior spot; pale stripe on metepisternum narrower than in group 1 and narrowly to widely separated to form a superior spot and an inferior stripe; metepimeron largely dark. the pale forming a posterior vertical stripe; abdominal segment 1 narrowly pale below on the sides; 2 with a median dorsal spot, the auricle, and the inferior posterior margin of the segment narrowly pale; 3 with a narrow dorsal stripe from the base to three-fourths the length of the segment, and with the inferior lateral margin very narrowly pale; on 4-6 the pale area is restricted to a small dorsal basal spot on each segment; 7 yellow to the transverse carina, with the inferior margin of this area broadly black, and with the lower border, posterior to the transverse carina, very narrowly if pale at all; 8-10 in lateral view black; basal black on dorsum of appendages extended apically twice as far as in group 1.

Progomphus sp.

Fig. 3, 7, 15

A single female was captured at La Tigrera, about ten miles from Santa Marta, on December 20, 1916. The Tamacal flows through La Tigrera, and the specimen was resting at an elevation of about eight feet on the tip of a dead twig of a small tree growing on the bank of the stream. It was found late in the afternoon, and further search then and during a subsequent visit failed to reveal more specimens. The species is apparently unnamed but I do not care to name it from such scanty material. A brief description of the single female follows:

Abdomen 30, hind wing 25.5. Labrum, nasus and frons in front rich dark brown; rhinarium and a small spot on the lateral margin of the nasus gray; frons above in front greenish yellow, the posterior half and the vertex brown, and the occiput darker brown. Postocellary ridges meeting in the median line in an angle of about 120° with no conspicuous median prominence. Occipital edge nearly straight, very slightly concave, a scarcely discernible median concavity; occipital hairs short.

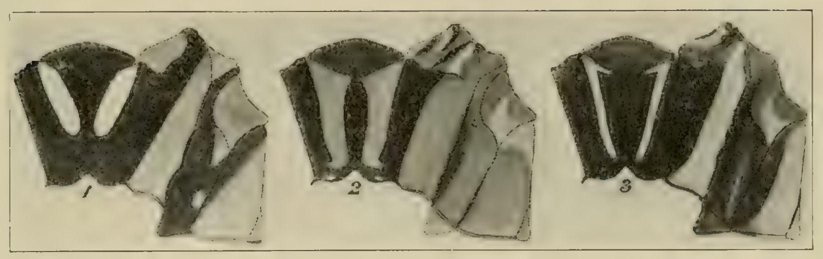
Prothorax brown, the anterior lobe lighter and the posterior lobe darker, the inflated areas of the median lobe greenish yellow. Thorax rich dark brown marked with greenish yellow (see fig. 3), the brown on the metepimeron lighter than on the mesepisternum. Beneath and coxae greenish yellow, the latter shaded and marked with light brown.

Abdomen brown, marked greenish yellow; 1 brown, pale below; 2 with a narrow median longitudinal stripe the length of the segment and the sides broadly pale; 3 and 4 with the merest trace of the same dorsal line, not discernible throughout the length of the segment on 4; 3-6 each with a large dorsal basal spot on either side of the median line, the two on each segment narrowly separated, and with the inferior lateral margin pale; 7 apparently pale basally to the transverse carina, and with the sides below, posterior to the carina, largely pale brown or yellowish; 8 and 9 dark brown or black above, the sides extensively paler brown or yellowish, similar to 7 posterior to the transverse carina; 10 black; appendages light brown or grayish, darker at the extreme base.

PLATE I

Figs. 1-3, diagrams of thoracic color patterns. Fig. 1, *Progomphus risi*, male, Gualan, Guatemala; fig. 2, *Progomphus pygmaeus*, male, Bolivar, Colombia; fig. 3, *Progomphus* sp., female, La Tigrera, Colombia, December 20, 1916.

Fig. 4, accessory genitalia of the second abdominal segment of *Progomphus pygmaeus*, male, Bolivar, Colombia, December 24, 1916.



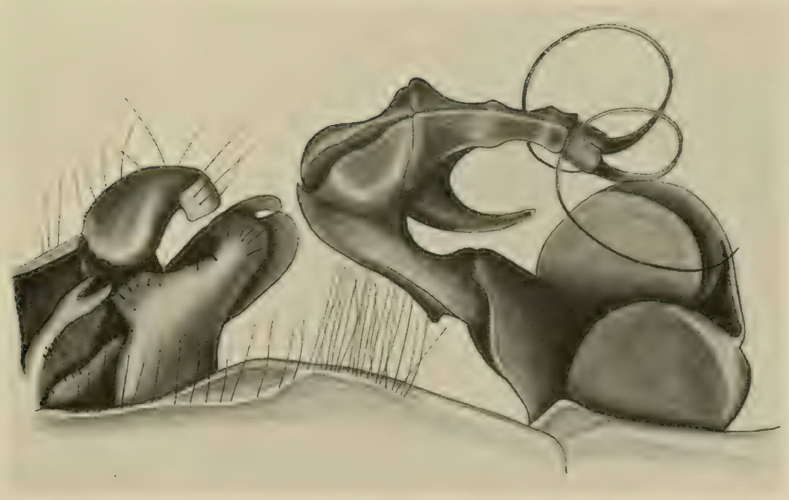


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PLATE II

Wing photographs by C. H. Kennedy. Fig. 5, *Progomphus pygmaeus*, male, Bolivar, Colombia, December 25, 1916; fig. 6, *Progomphus risi*, male, Gualan, Guatemala, June 16, 1909; fig. 7, *Progomphus* sp., female, La Tigrera, Colombia, December 20, 1916.

PLATE II

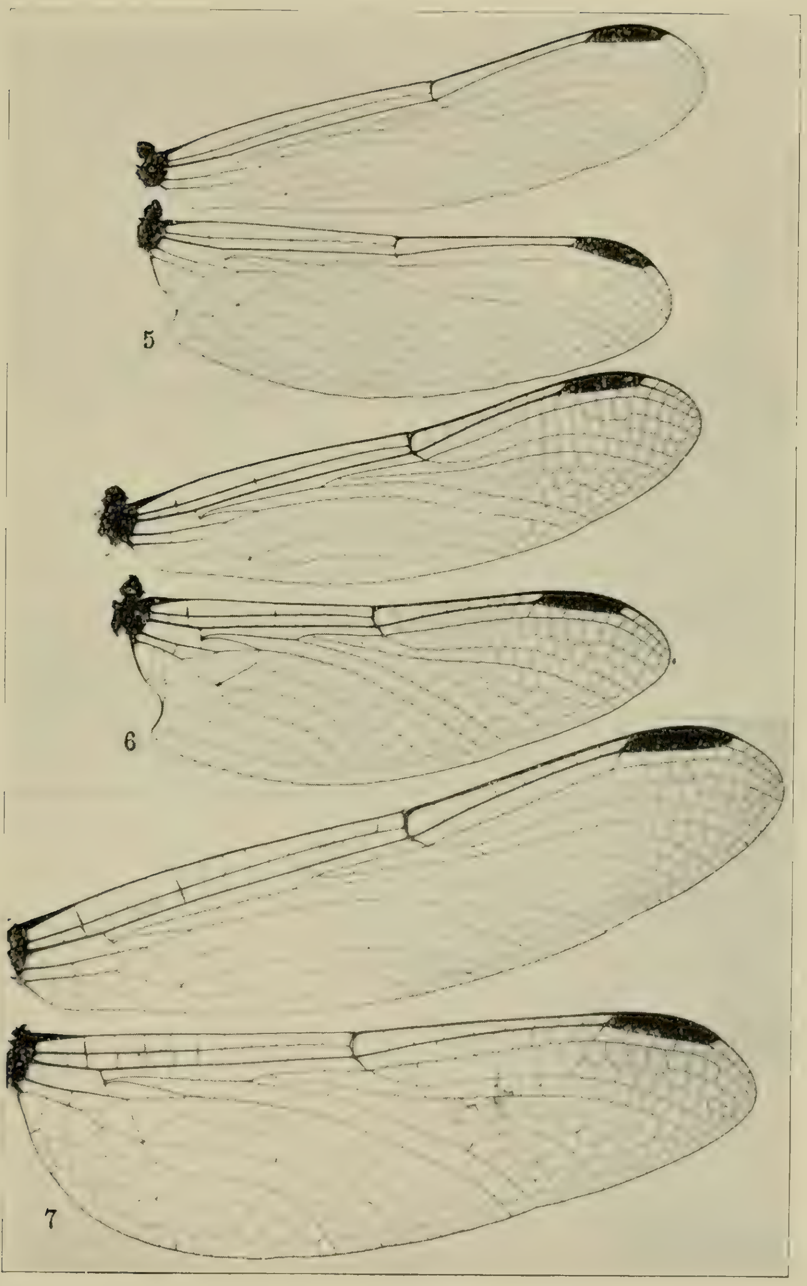
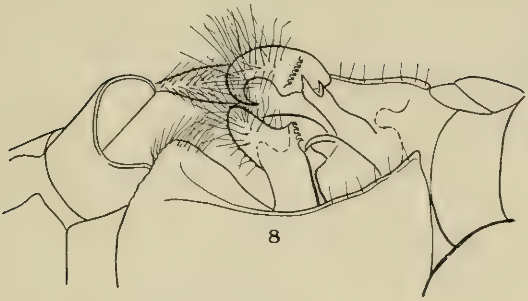


PLATE III

Figs. 8-11, *Progomphus risi,* type male and allotype female; figs. 12-14, *Progomphus pygmaeus,* male and female, Bolivar, Colombia, December 24, 1916; fig. 15, *Progomphus* sp., female, La Tigrera, Colombia, December 20, 1916.

Fig. 8, accessory genitalia of second abdominal segment; figs. 9 and 12, inferior views and figs. 10 and 12, lateral views of male abdominal appendages; figs. 11, 14 and 15, female vulvar lamina.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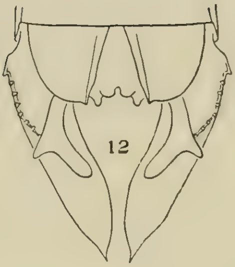
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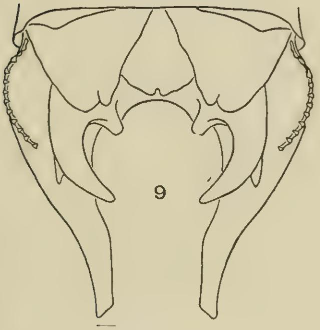
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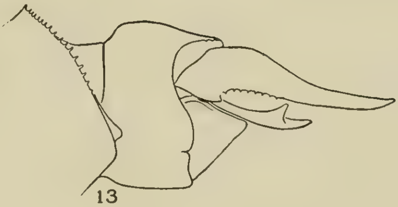
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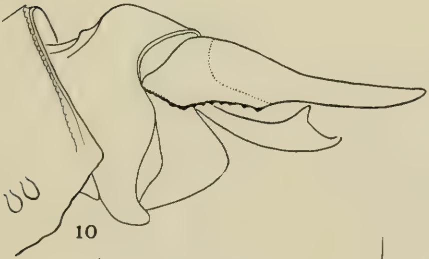
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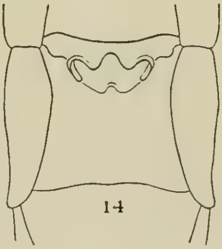
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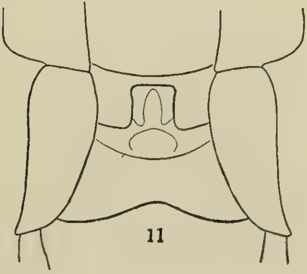
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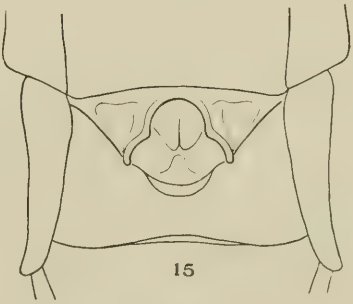
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NUMBER 78 MARCH 1, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

A NEW SPECIES OF GONIOBASIS

BY ANSON A. HINKLEY

Goniobasis goodrichi, new species.

Description: Shell acutely conical, solid; the last half whorl rather thin; color light brown. Apex of shell eroded, leaving six whorls entire (probably a perfect specimen would have ten or twelve whorls). Suture well defined. Surface of whorl marked with twelve to fourteen plications, slightly curved and covering all except the last half whorl. Whorls with many microscopical revolving lines which on some of the earlier whorls amount to carinæ. Body whorl angular or subangular (in young specimens the angle of the periphery is sharp). Aperture is ovate, with sinus below; acutely angled above; outer lip a little sinuate; columella curved, a little reflected; parietal wall with a thin callus, darkly colored. Operculum ovate, thin, brown; polar point close to the base on the left side.

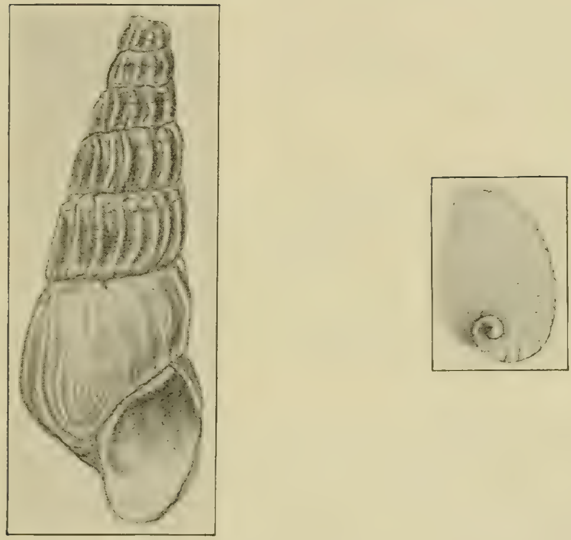
Seven specimens measure:

LENGTH	WIDTH	LENGTH OF APERTURE	WIDTH OF APERTURE	
25½ mm.	9½ mm.	8½ mm.	5½ mm.	Type
30	10½	10½	5½	
26	9½	10	5½	
25½	10	10	6	
25	9½	9½	5½	
25	10	10	5½	
20½	9½	9½	5½	

Type Locality: Tributary of Swan Creek, about five miles east of Aetna, Hickman County, Tennessee. Collected May, 1907, by A. A. Hinkley.

Remarks: The shell belongs to the group characteristic of Central Tennessee, the leading representative of which may be set down as *Goniobasis laqueata* Say. It differs from *Goniobasis curreyana* Lea, which, however, it approaches, in being acutely conical and in having microscopical revolving lines. It has not the bands of *G. duttonii* Lea, and is thicker and more attenuate. It is thicker, larger and the ribs are more strongly developed than in the case of *G. thorntonii* Lea. The shell more nearly resembles certain light colored specimens of *Goniobasis plicifera* Lea than any other species east of the Pacific coast region.

At the time the shells were collected they were identified as *Goniobasis athleta* Anth. Mr. Calvin Goodrich pointed out my error of determination and I have the pleasure of giving his name to this fine Goniobasis. The type specimen is in the Museum of Zoology, University of Michigan; co-types in my cabinet; author's examples in the National Museum, Philadelphia Academy of Natural Sciences, and in the collection of Dr. Bryant Walker of Detroit.



Goniobasis goodrichi Hinkley.

Type specimen, Shell × 3, Operculum × 4.

NUMBER 79 MARCH 1, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

NOTE ON *OREOHELIX IDAHOENSIS BAILEYI* BARTSCH

BY MINA WINSLOW

A large series of this Oreohelix was recently noticed in the collection of the Museum of Zoology, and the attention of the writer directed to it by Dr. H. A. Pilsbry. The shells were submitted to Dr. Paul Bartsch of the U. S. National Museum, who confirmed my identification and urged the publication of measurements of the series since it exhibits considerable variation in size and proportions.

The subspecies was described* from three specimens taken in the Seven Devils Mountains, Idaho. The present lot was collected in 1900 by I. C. Russell in the Snake River Canyon, Idaho, eight miles below the mouth of the Salmon River, on limestone. This locality is in the Seven Devils Mountains and may easily have been identical with the type locality of the subspecies.

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* No. 2155.—Proc. U. S. Nat. Mus., Vol. 51, pp. 331-333, with plate 31. November 24, 1916.

About 125 specimens varying from shells of only a few whorls to fully adult specimens of a little over five whorls compose this series. The illustration accompanying Dr. Bartsch's paper evidently shows a shell not quite mature, as fully grown shells have about one-half whorl more, and the ends of the peristome united by a heavy callus. Measurements of thirty-six fully adult specimens yield the following figures:

Greater diameter 12.1, lesser 11.1 mm., alt. 8.16, Index A/D, 67.35 average for 36 shells.

Greater diameter 14.2, lesser 13.0 mm., alt. 9.6, Index A/D, 67.60 largest in diameter.

Greater diameter 11.0, lesser 10.8 mm., alt. 7.7, Index A/D, 70.00 smallest in diameter.

Greater diameter 11.5, lesser 11.2 mm., alt. 9.7, Index A/D, 84.34 most elevated.

Greater diameter 12.3, lesser 11.0 mm., alt. 7.0, Index A/D, 56.91 most depressed.

Variation in diameter from 14.2 to 11, or 3.2 mm.

Variation in altitude from 9.7 to 7, or 2.7 mm.

Several features correlated with age variation are apparent. In young shells the sculpture of the early whorls is very distinct, consisting of raised spiral lines noticeably stronger after the nuclear one and one-half whorls. Shells of three or four whorls tend consistently toward a less elevated form than mature shells, a difference correlated with the sudden descent of the last whorl or half whorl to the aperture. In some specimens the descent has been so sudden that the peristome partially conceals the umbilicus and is placed almost directly below the preceding whorl. One of the specimens figured (figs.

4, 5, 6) is of this exaggerated form, combining almost the minimum. The difference between this and the more typical form is illustrated on the accompanying plate.

In color the shells vary from a brown with white ribs to a uniform chalky white—the latter condition probably due to weathering and bleaching. Embryonic shells are horn color or darker, rather fragile, and with a satin-like sheen. The number of ribs on the last whorl varies from about 16 to 24, of varying sizes and arrangement. In outline the whorls vary from well rounded to decidedly shouldered, the latter predominating in the majority of shells.

It may be said in general that the extremes of the series depart from the typical form to such a degree that only the presence of intermediate forms keeps them within the limits of the subspecies *baileyi*. It is evident, however, that the degree of variation exhibited is only in proportion to the number of specimens in the lot, and does not justify selection of specimens as typical of another new subspecies.

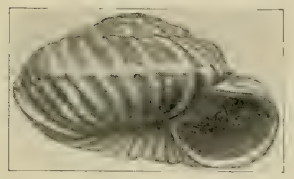
PLATE I

Figs. 1, 2, 3: *Oreohelix idahoensis baileyi* Bartsch. Most depressed specimen. Index 56.91.

Figs. 4, 5, 6: *Oreohelix idahoensis baileyi* Bartsch. Most elevated specimen. Index 84.34.

All figures enlarged 3 times.

OREOHELIX IDAHOENSIS BAILEYI BARTSCH PLATE I



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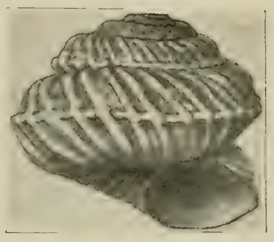

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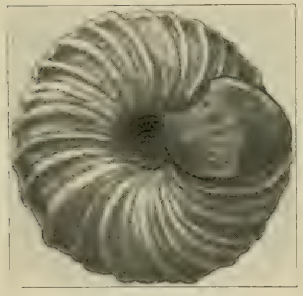

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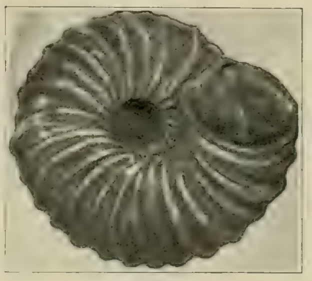

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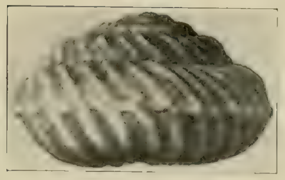

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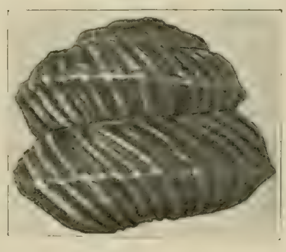

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NUMBER 80 APRIL 28, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

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A NEW GOMPHINE GENUS FROM BRITISH GUIANA WITH A NOTE ON THE CLASSIFICATION OF THE SUBFAMILY (ORDER ODONATA)

BY E. B. WILLIAMSON

Desmogomphus, new genus

Belonging to the legion Gomphoides of the *Monographie des Gomphines* and to the short-legged division of the legion. Separated at once from the "genre Zonophora," as defined in the *Monographie*, by the relatively short uncrossed triangle of the front wing and the simpler venation (anal area of front wing only one cell wide); and from the "genres Progomphus and Gomphoides" by the shorter stigma (in the front wing less than one-third as long as the distance from nodus to stigma), by the proximal angle of the subtriangle in the front wing distal to the arculus, and by the anal crossing in the hind wing proximal to the subtriangle a distance equal to the anterior side of the subtriangle.

Dr. Calvert (*Ent. News*, XIV, June, 1903) describes and figures the venation of a new species of Diaphlebia giving a careful analysis of the venational characters of Diaphlebia and Epigomphus.

If his *Diaphlebia nexans* is congeneric with the type species, *D. augustipennis*, as there is no reason to doubt, then Diaphlebia is the nearest relative of Desmogomphus. Desmogomphus has a much shorter stigma (about one-eighth the wing length, about one-sixth or slightly longer in Diaphlebia); the anal area of the front wing is only one cell wide (two in Diaphlebia); and the hind border of the hind wings is normal (not excavated basally as in Diaphlebia).

Other venational characters of Desmogomphus may be briefly summarized: triangles, supratriangles, and subtriangles all free except the triangle of the hind wing, which is once crossed; triangles of front and hind wings dissimilar, that of front wing nearly equilateral, with the anterior side very slightly the shortest, that of hind wing with the proximal side much the shortest; subtriangles distinct (i.e., A angled at the proximal angle of the subtriangle); M_4 and Cu_1 in front wing more widely separated at the level of the nodus than at the triangle; M_3 in front wing terminating far proximal to the level of the stigma; cross-veins between M_{1-3} and M_4 numerous and unspecialized; two rows of post-trigonal cells in the front wing, three, followed immediately by two, in the hind wing; forking of M_{1-2} and M_3 unsymmetrical; basal antenodal of second series wanting; distal thickened antenodal the fifth; anal area of front wing one cell wide, of hind wing three cells wide, the two anterior postanal cells undivided; anal triangle three-celled, not reaching the anal angle; membranule wanting.

While the affinities of Desmogomphus are, I think, with Progomphus and Gomphoides, there is a striking resemblance between the front wings of Ischnogomphus and Desmogomphus. Ischnogomphus and Progomphus, for example, belong, I believe, to two lines of descent. By its characters Desmogomphus indicates the common origin of these two lines, and an apparent link between them justifies its name. The relationships will be discussed in the second part of this paper.

Desmogomphus, compared with its allies, is a relatively slender gomphine and the legs are weaker and slightly longer than in related genera (Progomphus and Gomphoides; I do not know Diaphlebia). Type of genus, *Desmogomphus tigrivensis*, new species.

Desmogomphus tigrivensis, new species

Abdomen, male 30.5; hind wing, male 24.

Male.—Rear of head dull brown, darker about the foramen and lighter below, where it is indefinitely patterned with dull yellow; genae, face, and frons above bluish gray or lead-colored, obscurely and indefinitely patterned with brown as follows: labrum with the anterior edge (dark brown, almost black) and a median posterior spot, rhinarium and nasus with more or less diffuse central areas, and frons in front, excepting the angle, and above at the base in the median line. Angle of frons low and rounded. Vertex and occiput dark brown or black; anterior face of vertex relatively flat, in a plane about parallel to the nasus, smooth and bare; dorsal surface with a low median longitudinal sulcus, punctate and bearing hairs equal in length to those on the occipital border, the lateral margins of the middle lobe of the prothorax, and the mesothoracic transverse carina; occipital border broadly concave.

Prothorax brown; anterior lobe largely dull yellow, especially above and in front; middle lobe with a median posterior geminate bluish-gray spot and one or two yellow areas on each side below; hind lobe with yellow shadings on the posterior border.

Thorax rich dark brown marked with olive green. Beneath pale yellowish brown.

Abdomen relatively slender, dark brown basally, progressively darker apically till the apical segments, beginning at the fourth or fifth, are black; marked with yellowish or greenish as follows: segment 1 largely pale, the dorsal apical half or slightly less, brown;

sides below of segment 2, including the auricles and dorsal median longitudinal bar on the apical half of the segment, pale; segment 3 with the sides pale below basally, and with a narrow longitudinal mid-dorsal line, which is widest at the base of the segment, thread-like through most of its length, and does not quite reach the apex; segment 4 apparently entirely brown with the exception of a reduced and frequently interrupted longitudinal mid-dorsal thread-like line extending the full length of the segment except the extreme apex, and a small pale area on either side below basally; segment 5 with a more or less distinct basal median spot, the remnant of the dorsal line, and a small pale area on either side below basally; segment 6 similar to segment 5, but the lateral and median pale areas are slightly larger; in segment 7 these pale spots are joined in a basal band, encircling the segment and occupying about one-fifth its length; segments 8 to 10 black, segments 8 and 9 laterally and segment 10 dorsally and laterally obscurely and indefinitely mottled with dark reddish brown; segment 10 with the apical inferior side obliquely cut; superior appendages yellow, the inferior reddish horn, both tipped with black. The superior appendages are 1.5 mm. long, and segments 8, 9, and 10, measured at mid-height on the side, are respectively 2.4, 1.4, and .8 mm. in length.

Wings hyaline, very slightly tinged yellowish basally, venation dark, stigma brown, covering three to four cells, 2.7 mm. long in the front wing and 3 mm. long in the hind wing; antenodals of front wing 12 or 13 mm., of hind wing 9 or 10 mm.; postnodals of front wing 10 to 13 mm., of hind wing 9 or 10 mm.

Legs weak, of median length, light reddish brown, darker apically beginning on the apices of the femora; apices and angles of the tibiae, and the tarsi black; the first femora darker above through most of their length. Femora circular, tibiae quadrangular in cross-section. First femora with a longitudinal row of very light yellowish-brown inconspicuous bristles on its ventro-posterior surface; on the postero-ventral surface are scattered small black spines which form a fairly distinct longitudinal row or tract; scattered among these spines are four to six black bristles or long slender spines; on the antero-ventral surface is an inconspicuous row of a few small black spines. Second femora with a row of long almost colorless bristles on the ventro-posterior surface as on the first femora; ventral surface basally with many small black spines which, passing apically, resolve themselves into two rows, the posterior row or tract of uniformly small spines more or less irregularly scattered, the anterior row definitely single-rowed with the spines increasing in size from the base to the apex. Third femora similar to the second, but the row of pale bristles on the ventro-posterior surface confined to the apical half or two-thirds, the black spines on the ventral surface less numerous, the anterior and posterior rows, in the apical half, equally definite and well-defined single rows, and the spines of the posterior row longest at about two-thirds the length of the femur, diminishing in size apically and basally from this point; the anterior row is similar to the anterior row on the second femora. The first femora are 3 mm. long; the second, 3.4 mm.; and the third, 5 mm.; the first tibiae are 2.8 mm.; the second, 3 mm.; and the third, 3.2 mm. (all measurements on the dorsal surface).

Accessory genitalia, including the penis, relatively simple; the first hamule is a flattened plate, convex externally, concave internally, with the anterior edge the heavier and with the apical anterior corner bearing a strong interno-posteriorly directed hook; second hamule thornlike, slightly flattened.

Described from two males, Tiger Creek, near Tumatumari, on the Potaro River, British Guiana, February 5 and 7, 1912, the first the type in Coll. E. B. W., the second in Coll. P. P. C. Both specimens were taken resting on the flat surface of leaves overhanging Tiger Creek. One was taken only a short distance below Washerwoman Falls, the other possibly a mile below.

ON THE CLASSIFICATION OF THE GOMPHINAE[1]

The Gomphinae, as used in this paper, is in the restricted sense of modern authors, the latest of whom is Tillyard in the *Biology of Dragonflies*, who states (p. 258): "We still need a thorough study of the Gomphinae, the present division into two tribes being only tentative."[2] Needham (*A Genealogic Study of Dragon-Fly Wing Venation*, pp. 737–38) says: "Variation from the type is slight considering the large number of genera in the group, and such as there is, it does not lend itself readily to serial arrangement." And after discussing various characters which appear scattered through the subfamily, he adds:

> Possibly these features indicate the tips of numerous short developmental twigs. The brief records of the several parts are certainly contradictory, and the parts themselves, which one might use as bases for the first divisions of the group, seem so nearly of equivalent importance that one may hardly choose between them with assurance. Probably the records of other organs will be more easy of interpretation.

This was written sixteen years ago and no attempt has been made by students to employ other organs in elucidating relationships within the subfamily. Since figures of wings are more available and more easily interpreted than figures of any other part it seems worth while to attempt some statement of relationships based on a study of this organ, thus preparing a tentative outline of the classification of the subfamily to be corrected and revised by later studies of other organs.

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[1] Figures of venation of many gomphines are found in the following papers: James G. Needham, "A Genealogic Study of Dragon-Fly Wing Venation," *Proc. U.S. Nat. Mus.*, 1903; Philip P. Calvert, "On Some American Gomphinae (Odonata)," *Ent. News*, XIV (1903); E. B. Williamson, "The Dragonflies (Odonata) of Burma and Lower Siam. II. Subfamilies Cordulegasterinae, Chlorogomphinae and Gomphinae," *Proc. U.S. Nat. Mus.*, 1907; E. B. Williamson, "A New Cyanogomphus (Odonata)," *Ent. News*, XXVII (1916); E. B. Williamson, "Two Interesting New Colombian Gomphines (Odonata)," *Occ. Papers Museum of Zoology*, University of Michigan, No. 52, 1918; E. B. Williamson, "A New Species of Agriogomphus (Odonata)," *op. cit.*, No. 59, 1918; E. B. Williamson, "Archaeogomphus, A New Genus of Dragonflies (Odonata)," *op. cit.*, No. 63, 1919.

[2] Tillyard's use of size in defining the two tribes is not justified, as in the Ictinini, "moderate to large-sized Gomphinae," occur many small species, among them the smallest gomphine known, and in the Gomphini are a number of large species. Under his series 1, the Gomphoides series of the Ictinini, he says "Larva with elongated abdomen," but the larva of Hagenius is circular.

Since de Selys' *Monographie des Gomphines* was published our definition of Gomphinae has grown by reduction, and it may be noticed that three of the five palaeogenic groups defined by Tillyard, in *The Biology of Dragonflies*, are groups which de Selys included in the Gomphinae. The Gomphinae of recent authors is the "Division Integrilabiées" of de Selys, containing over fifty genera and three hundred and ninety species.

If the wings of the gomphine *Archaeogomphus hamatus* and the libelluline Hypothemis are compared certain common characters are obvious: the basal crossing of *ac*, the four-sided triangles, the undifferentiated cross-veins between M_{1-3} and M_4, and the unsymmetrical forking of M_{1-2} and M_3. The corduline genus Cordulephya has these characters less marked, *ac* is not so basal and M_{1-2} and M_3 are symmetrically forked. If the wings of *Gomphus dilatatus*, for example, are compared with those of Archaeogomphus it will be seen that in the former *ac* is very distal, the triangles are typical, the cross-veins between M_{1-3} and M_4 are reduced and specialized, and the forking of M_{1-2} and M_3 is symmetrical. I believe these four characters, in connection with other venational characters, can be employed as valuable criteria in classifying the Gomphinae.

It is assumed that the four characters as found in Archaeogomphus are primitive at least for the Gomphinae and that they may be employed as criteria for determining the more primitive members of any particular series. The association of these characters in forms generally recognized as primitive in both Gomphinae and Libellulinae gives weight to this assumption. The four-sided triangle and the unspecialized cross-veins between M_{1-3} and M_4

are certainly primitive gomphine wing characters. When we find a basal position of *ac* and an unsymmetrical forking of M_{1-2} and M_3 associated with these two characters in the same wings it may safely be assumed that the basal position of *ac* and the unsymmetrical forking are relatively primitive characters also.

1. *The Epigomphus series.*—This includes the following genera previously included in the grand genus Gomphus of de Selys: Archaeogomphus, Agriogomphus, Cyanogomphus, Epigomphus, Ischnogomphus, Leptogomphus, Macrogomphus, and Microgomphus. In this series alone, in Archaeogomphus, and to a lesser extent in Microgomphus, is a four-sided triangle found in the subfamily. (It is indicated also in the hind wing of the single figure I have of the venation of Neogomphus.) At the other end of the series from Archaeogomphus is the more densely veined *Macrogomphus quadratus* with its strikingly curved sectors. The series is distinguished by free triangles, supratriangles, and subtriangles, and numerous cross-veins between M_{1-3} and M_4. In the higher members of the series *ac* moves distally, M_{1-2} and M_3 form a symmetrical fork, and there is an increase in density of wing venation. In the next series specialization by addition has been carried still farther. Of the Epigomphus series three genera with twenty-two species occur in the Oriental Region and five genera with sixteen species occur in the Neotropical Region.

2. *The Progomphus series.*—This includes the grand genera Progomphus and Gomphoides of de Selys and Diaphlebia and Desmogomphus. Genera of this series may be recognized by having the triangles, supratriangles, and subtriangles more or less cross-veined, by dissimilar triangles and subtriangles in fore and hind wings, the triangles of the fore wings being relatively shorter and of the hind wing relatively longer; by the absence of sectors of Rs and M_4 and of strongly developed trigonal supplements, and by the outer side of the triangles not distinctly concave.

In Desmogomphus we have the most primitive genus of the series. The front wing of this genus if considered alone could as well be referred to the Epigomphus series. At the opposite end of the series is the densely veined *Gomphoides stigmata*, for example.

Four genera (if Calvert's views on synonymy, *Biologia Centrali Americana,* are followed) containing about sixty species comprise this series which is Neotropical with a few species which have penetrated into the Nearctic Region.

3. *The Gomphus series.*—This includes the grand genus Gomphus of de Selys less the Epigomphus series. It is the dominant gomphine type in the world at the present time, being represented by more than thirty genera and two hundred and fifty species. It is well represented in all the zoogeographical regions except the Neotropical, where only one genus in the south and one in the north occur. It holds a place in the subfamily similar to the position of the tribe Agrionini in the Agrioninae. Associated with uncrossed triangles, supratriangles, and subtriangles is a reduction and specialization in the cross-veins between M_{1-3} and M_4 (see Davidius under the Hagenius series). This last character is unique in the Anisoptera (see the Hagenius series) and can hardly be associated with greater wing efficiency. The Gomphinae generally, while capable of swift and mobile flight, spend a relatively small portion of their lives on the wing when compared with some of the aeshnines, cordulines, and libellulines, and the genera of this series are no exception to the rule. However the reduction in the venation has been brought about, the fact remains that here we have a different condition from that found in the two preceding series where the higher members are the more densely veined.

The series is very compact and the venational differences between genera are slight.

4. *The Zonophora series.*—Zonophora, the single genus of this series, is characterized by the triangles and subtriangles of fore and hind wings similar, the triangles long and once crossed, the

subtriangles and supratriangles all free, absence of trigonal supplements and sectors of Rs and M_4, and by having the proximal angle at the point of separation of A_1 from Cu_2+A_1, nearly a right angle, and not as obtuse as the distal angle at the same point. Its affinities are with the Hagenius series, and since I regard the latter as a series undergoing reduction and because of the uncrossed supratriangles and subtriangles in the Zonophora series, I believe the latter series has undergone reduction. The genus is represented by three species confined to the Neotropical Region.

5. *The Hagenius series.*—This is another small compact series, characterized by a distinct trigonal supplement in both wings, with the distal side of the triangle posterior to the attachment of the trigonal supplement distinctly concave. In the other characters of the triangles, supratriangles, and subtriangles, this series resembles the Zonophora series. But the Hagenius series is distinct from all others, excepting the Gomphus series, in that a considerable reduction of the cross-veins between M_{1-3} and M_4 has taken place.

Hagenius with a single species (unless a second species, *gigas*, from the Oriental Region should prove to be really congeneric) occurs in the Nearctic Region; and Sieboldius, with three species, occurs in the Palaearctic and Oriental Regions.

The genus Davidius has generally been associated with Hagenius and Sieboldius. I do not know the genus well enough to be certain, but I believe it belongs to the Gomphus series, being probably the most primitive member of that series. If this is correct free triangles is not an infallible character of the Gomphus series any more than crossed triangles is an infallible character of the Progomphus series.

6. *The Diastatomma series.*—I know the venation of the genus Diastatomma only from the figure in the *Monographie des Gomphines*, and the venation of Lindenia and Isomma not at all. Hence, I have to assume that the Legion Lindenia of de Selys is a single series and that the genera I know, Gomphidia, Ictinus, and

Cacus, are representative of the series. In the slight concavity of the distal side of the triangles the Hagenius series is suggested; in the dissimilar subtriangles of fore and hind wings and the dense venation the Progomphus series is suggested, but the triangle of the front wing tends to be longer, nearer the shape of the triangle of the hind wings, in the Diastatomma series; it is unique by the presence of a strongly developed sector of Rs and a usually less well-developed sector of M_4. Of the twenty-seven species in the six genera in this series, six belong in the genus Gomphidia and sixteen in Ictinus. Cacus of the Neotropical Region, with one species, alone occurs in the New World; Lindenia with a single species is Palaearctic; the remainder are Ethiopian and Oriental.

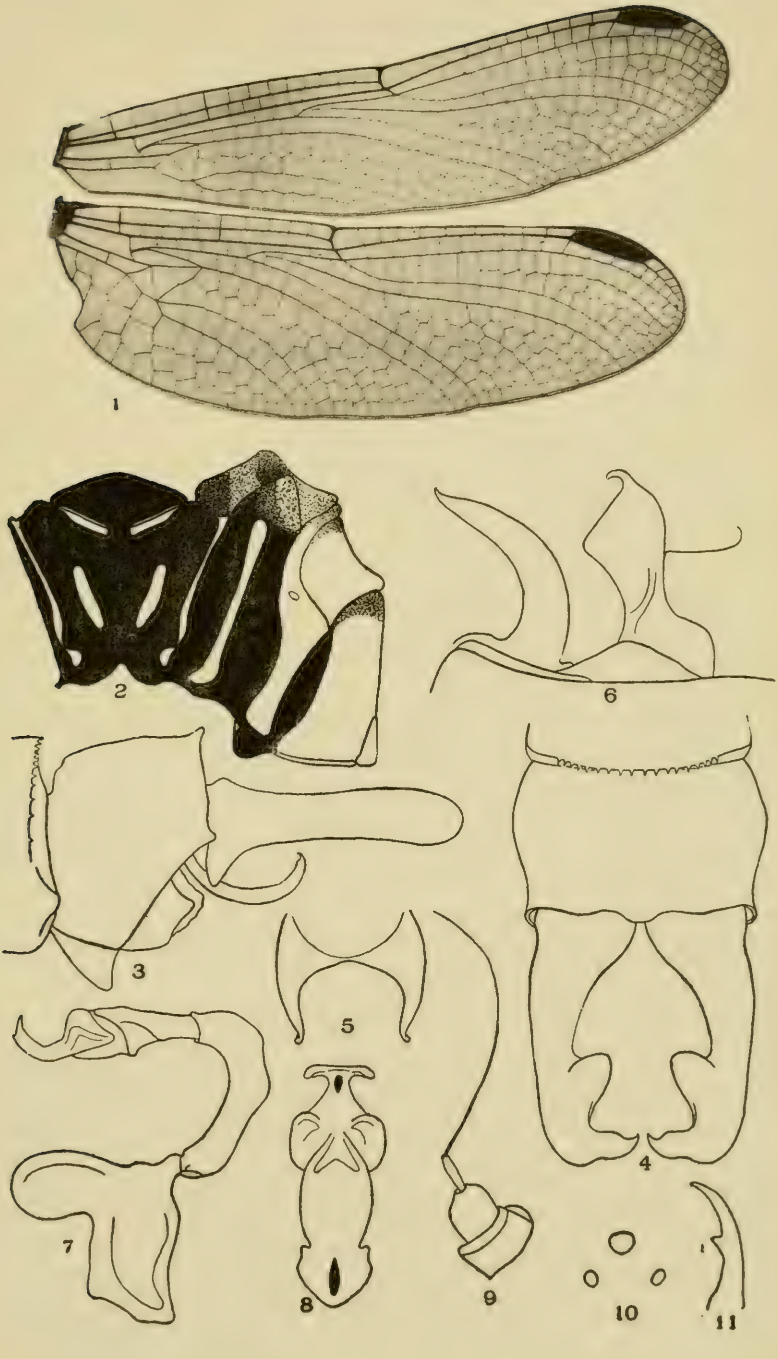
Series	Neotropical	Nearctic	Palaearctic	Ethiopian	Oriental	Australian
Epigomphus.......	x	....	....	....	x	....
Progomphus.......	x	x	....	....	....	....
Diastatomma......	x	....	x	x	x	....
Zonophora.........	x	....	....	....	....	....
Hagenius..........	....	x	x	....	x	....
Gomphus..........	x	x	x	x	x	x

The foregoing diagram indicates the relationships of the six series as I understand them. From the vertical line of primitive and simple winged forms the Diastatomma line branched off and became by addition a densely veined type. From some dense-veined member of this line a branch developed which by reduction resulted in the Hagenius and Zonophora series. It is possible these two series should be shown arising independently from the Diastatomma line. The Progomphus series is another lateral branch from the vertical line, developing another type of dense-veined forms. From some dense-veined member of the Epigomphus series a branch appeared which by reduction gave rise to the Gomphus series.

PLATE I

All figures of *Desmogomphus tigrivensis*, n. gen. and n. sp., male type specimen.

Figure 1, wings; 2, diagram of thoracic color pattern; 3, abdominal appendages in profile; 4, superior appendages in dorsal view; 5, inferior appendage in ventral view; 6, hamules fully extended, the first hamule the broader one; 7, seminal vesicle and penis in profile; 8, ventral view of apex of first joint of the penis and of the second and third joints; the larger opening is in the apex of the first joint; in relaxing and expanding the genitalia it was noticed that air and fluids were discharged through this opening; 9, antenna, inner surface; 10, relative position of the ocelli; 11, third tarsal claw.



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OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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THREE NEW SNAKES OF THE GENUS LAMPROPELTIS

BY FRANK N. BLANCHARD

While engaged upon a monograph of the king snakes, genus Lampropeltis, it has been found necessary to propose several new names, either to correct the systematic status of forms already known or to call attention to forms hitherto unknown. Two of these names appeared in this series nearly a year ago[1]; the others were to await the publication of the monograph, but probable delay in this makes it advisable to record separately and in advance the remaining three names.

For the loan of specimens the writer desires to express thanks to Dr. Henry W. Fowler, of the Academy of Natural Sciences of Philadelphia, to Miss Mary C. Dickerson, of the American Museum of Natural History, and in particular to Dr. Leonhard Stejneger, who, aside from every courtesy connected with the loan of specimens, has assisted with advice on many puzzling points throughout the preparation of the revision of the genus, which is now nearly completed.

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[1] *Occasional Papers, Mus. of Zool.*, University of Michigan, No. 70, May 5, 1919.

In naming one of the new forms for Professor Alexander G. Ruthven, Director of the Museum of Zoology of the University of Michigan, the writer wishes to express his deep appreciation for three years of constant advice and encouragement.

Lampropeltis elapsoides virginiana, new subspecies

Diagnosis: Similar in scutellation and proportions to *L. elapsoides elapsoides* (Holbrook), but the red areas instead of completely encircling the body are restricted to black-bordered dorsal saddles which extend upon the ends of the ventral plates.

Range: Northern North Carolina and Virginia, east of the Allegheny Mountains.

Type Specimen: United States National Museum No. 21163; Raleigh, North Carolina, June 16, 1893.

Description of Type Specimen: Ventral plates, 183; anal single and entire; caudals, 44 pairs; dorsal scale rows, 19 on middle of body, 17 anteriorly and posteriorly (formula 19-17-19-17); upper labials, 7; lower labials, 7 on the right side and 8 on the left; 1 preocular, 2 postoculars; 1 temporal of the first row and 2 of the second; no loreal plates, the prefrontal in contact with the second upper labial on each side; nasal divided; anterior chin shields in contact with each other, the posterior nearly as large, in contact with each other anteriorly, diverging somewhat posteriorly; rostral protruding, as in *L. elapsoides elapsoides;* other head shields normal for the genus.

Total length, 473 mm.; tail length, 73 mm.; tail therefore about 13 per cent of total length. Sex, male.

The dentition is as follows: maxillary teeth, 13 on each side; mandibular teeth, 14 on the left side, 15 on the right; palatine teeth, 10 on the left side; pterygoid teeth, 22 on the left and 19 on the right.

Pattern of body composed of 18 dorsal saddles of red, bordered with black, separated by whitish areas, and extending upon the ends of the ventral plates; 4 additional saddles of red on the tail. The dorsal saddles are from five to eight scales in length above, narrowing to two to four scales on the first row. The black borders are one and one-half to two scales wide on the mid-dorsal line and one-half to one scale on the first row. The whitish cross-bands are about one and one-half scales wide above, widening suddenly on the lower rows to four or five scales on the first row. On the belly, opposite each dorsal whitish cross-band, is a large squarish blotch of black.

On the head a black band, 2 mm. in width, crosses the posterior portions of the parietal plates, leaving their tips whitish, and ending on the seventh upper labials. The frontal and temporals are mostly black, the rest of the head mostly light, probably red in life. The chin and throat are immaculate whitish.

Remarks: So few specimens of this form are known that no general description can be drawn up. It is by no means certain that all the specimens here referred to *virginiana* are conspecific with the type.

The other specimen from Raleigh (U.S.N.M., No. 56197) is almost identical with the type in structural features, but the red saddles extend farther upon the belly. Anteriorly their black borders are separated by only a narrow mid-ventral strip of whitish, while posteriorly they meet below. The specimen from Cuscowilla, Virginia (U.S.N.M., No. 26181), is a juvenile closely similar to the two preceding in scutellation and nearly like the last in pattern, but there is a tendency to develop black pigment on the fore part of the belly between the ends of the red saddles. This tendency becomes more and more pronounced posteriorly, developing also opposite the whitish dorsal cross-bands, so that the latter half of the belly is nearly all black.

The specimen from Appomattox County, Virginia (U.S.N.M., No. 4466), lacks the head but otherwise shows itself to be almost identical with the type. The ventral borders of the red saddles are, however, less well defined, and black pigment on the belly is less regularly distributed.

The specimen from Alberene, Virginia (U.S.N.M., No. 25321), shows a few differences from the others. The twenty-first row of scales is represented by four scales on one side of the body, the lower labials are 9 on each side, the loreals are present, the upper anterior temporals are present although small, and the number of red saddles reaches 25. Furthermore the black borders of these saddles show very little of that widening in the mid-dorsal region that is so characteristic of *elapsoides*. The red saddles extend well upon the ventral plates and are sharply delimited by their black borders. Otherwise there is very little black pigment on the belly. The whitish cross-bands are rather strongly mottled with darker on the sides, and all the dorsal scales in the red areas are less strongly, but very distinctly, mottled with dark. In scutellation this specimen is perhaps nearer to *L. triangulum triangulum*, but it can certainly never be regarded as identical with that form, and, all things considered, it seems much better to identify it provisionally as *virginiana*.

The specimen from the District of Columbia (Museum of Zoology, University of Michigan, No. 52203) is much more puzzling. The scutellation is closely like *elapsoides*, but the whole snake is larger and stouter, measuring 581 mm. even with the tip of the tail missing. Furthermore the red saddles number 27 and overlap the ends of the ventral plates only a little. The black borders of the saddles show scant if any tendency to widen in the mid-dorsal region, and the head shows faint but recognizable vestiges of the common parietal and supraocular spots of *triangulum* and some specimens of *L. triangulum syspila* (Cope). There are no lateral spots alternating with the dorsal saddles, but ante-

Explanatio
of 1

Museum
U.S.N.M.
U.S.N.M.
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U.S.N.M.
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Univ.Mich.
Acad.Phila.

LIST OF SPECIMENS OF *Lampropeltis elapsoides virginiana*

Explanation.—When two numbers occur in the same space the upper refers to the left side, the lower to the right. Abbreviations: Acad. Phila. = Academy of Natural Sciences of Philadelphia; Univ. Mich. = Museum of Zoology, University of Michigan, U.S.N.M. = United States National Museum.

Museum	Number	Locality	From Whom Received	Sex	Scale Rows	Ventrals	Caudals	Supralabials	Infralabials	Oculars	Temporals	Total Length in Millimeters	Tail Length Divided by Total Length	Number of Annuli	Remarks
U.S.N.M.	4366	Appomattox Co., Va.	C. W. Stratham	[illegible]	19-18-19-17	178	39					471		18	Head missing
U.S.N.M.	21163	Raleigh, N.C.	H. H. and C. S. Brimley	♂	19-17-19-17	183	44	7	8 7	1, 2	1+2+3 1+2+4	473	145	22	Loreals absent Type
U.S.N.M.	25321	Alberene, Albemarle Co., Va.	R. E. Shaw	[illegible]	19-20-19-17	170	43	7	9	1, 2	2+2+3	558	131	25	Only four scales of twentieth row
U.S.N.M.	20181	Cuscowilla, Mecklenburg Co., Va.	Wm. Townes	[illegible]	19-17-19-17	174	35	7	8	1, 2	1+2+3	233	120	23	
U.S.N.M.	56107	Raleigh, N.C.	Julius Hurter	♀	17-19-17	186	40	7	8 7	1, 2	1+2+3	529	136	21	Loreals absent
Univ. Mich.	52203	St. Elizabeth's Hospital, District of Columbia	Army Medical Museum	[illegible]	19-18-19-17-15	173	36	7	9 8	1, 2	2+3+3 1+2+4	581		27	Tip of tail missing
Acad. Phila.	5601	Delaware?		[illegible]	19-21-19-17	188	[illegible]	7	9	1, 2	2+2+3 2+3+3	285	133	20	Twenty-first row only slightly represented

riorly on the belly there is, as in the type, a single large black blotch opposite each of the dorsal whitish bands. Posteriorly, however, these blotches become irregular and the black pigment is much increased in amount. Whatever this specimen is, it is not a *triangulum*. It may represent a derivative of *triangulum* as yet unrecognized, but in view of the great variability exhibited by specimens from the Middle Atlantic region and the lack of representatives from large areas of Virginia, Delaware, and Maryland it is not possible at present to define the characters of this unknown form or even to be certain that such a form exists. The present plan of identifying this aberrant specimen as *virginiana* is admittedly an expedient for delaying the settlement of the difficulty until more specimens shall be available for study. The dentition of this individual, except for the pterygoid teeth, is as follows: maxillaries, 13; mandibulars, 13; palatines, 11.

The specimen in the Academy of Natural Sciences of Philadelphia (No. 3601) is of uncertain origin. It may be from Delaware. It is closely similar to the Cuscowilla specimen and is with little doubt a *virginiana*.

The form *virginiana*, as defined by the type and represented by all the others listed except the two doubtful ones (those from Alberene and the District of Columbia), is without doubt a derivative of *elapsoides* by an alteration of the pattern closely similar to that which took place when the subspecies of *triangulum* changed from the ringed to the saddled type of pattern. Whether this change toward the *triangulum* type went so far that individuals of *virginiana* were able to hybridize with the degenerating section of *triangulum* of the Middle Atlantic states seems improbable. It is more likely, as indicated above, that there exists in this region a degenerate derivative of *triangulum*. This question can be settled only when specimens shall be available from the Delaware-Maryland peninsula and from eastern Virginia.

Lampropeltis triangulum nelsoni, new subspecies

Plate I, Figure 1

1887. *Ophibolus multistratus* Cope (part), *Bull. U.S. Nat. Mus.*, No. 32, p. 78 (Guanajuato).

1887. *Ophibolus doliatus coccineus* Cope (part), *Bull. U.S. Nat. Mus.*, No. 32, p. 78 (Guadalajara; Colima).

1894. *Coronella micropholis* var. A. Boulenger, *Cat. Snakes Brit. Mus.*, II, 204.

1899. *Lampropeltis micropholis oligozona* Stejneger, *N. Amer. Fauna*, No. 14, p. 70 (Maria Madre Island).

Diagnosis: Similar to *L. triangulum annulata* (Kennicott) and to *L. polyzona* Cope, but distinguished from the former chiefly by the fact that the snout region is mottled with lighter and the red areas are broader and completely encircle the body; and from the latter in the mottled instead of cross-banded snout, in the greater width of the red rings, and the complete absence of black tips on the red scales.

Range: Western Mexico, from Acambaro in the state of Guanajuato to southern Sinaloa and south to Colima, including the Tres Marias Islands.

Type Specimen: United States National Museum No. 46552; collected by E. W. Nelson at Acambaro, Guanajuato, Mexico, in October, 1892.

Description of Type Specimen: Ventral plates, 206; anal single and entire; caudals, 42 pairs; dorsal scale rows somewhat irregular in number, for the most part 21, but numbering only 20 anteriorly, reaching 22 and 23 behind the middle, and ending with 19; upper labials, 8 on each side, due to interpolation of a third; lower labials, 10 on the left side and 9 on the right; 1 preocular; 2 postoculars; 2 temporals in the first row and 3 in the second; loreal longer than high; nasal divided; anterior chin shields in contact with each other and with the first 4 lower labials; posterior chin shields shorter and narrower than the anterior, in contact with each other

Explanc

Museum
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A.M.N.H.
A.M.N.H.
A.M.N.H.
A.M.N.H.
Acad.Phila.

[redacted], (b) by an absence of black tips

LIST OF SPECIMENS OF *Lampropeltis triangulum nelsoni*

Explanation.—When two numbers occur in the same space the upper refers to the left side, the lower to the right. Abbreviations: Acad. Phila. = Academy of Natural Sciences of Philadelphia, A.M.N.H. = American Museum of Natural History, U.S.N.M. = United States National Museum.

Museum	Number	Locality	From Whom Received	Sex	Scale Rows	Ventrals	Caudals	Supralabials	Infralabials	Oculars	Temporals	Total Length in Millimeters	Tail Divided by Total Length	Number of Annuli	Remarks
U.S.N.M.	12680	Guanajuato, Mex.	A. Dugés	Male	21-19-17	203	45	7	9	1-2	2+3+5 2+3+4	280	128	10	
U.S.N.M.	24684	Maria Madre Island, Mex.	E. W. Nelson	Female	21-23-21-19	228	50	7	8 9	1-2	2+3+4	1070	121	16	
U.S.N.M.	24967	Guadalajara, Mex.	J. J. Major	Male	21-20-21-19-17	213	54	7	9	1-2	2+3+4	661	150	24	
U.S.N.M.	24968	Guadalajara, Mex.	J. J. Major	Female	21-19-21-19-17	213	49	7	9	1-2	2+3+4	555	137	21	
U.S.N.M.	30504	Mexican Plateau, Mex.	F. Sumichrast	Male	21-19-17	214	50	7	9	1-2	1+3+4 2+3+4	940	130	22	
U.S.N.M.	30505	Mexican Plateau, Mex.	F. Sumichrast	Male	21-19-17	214	50	7	10	1-2	2+3+4	550	138	19	
U.S.N.M.	31491	Colima, Mexico	G. Xantus	Female	21-19-17	212	44	7		1-2	2+?+?	743	120	19	
U.S.N.M.	31492	Colima, Mexico	G. Xantus	Male	21-19-17	211	52	7	9 ?		2 ?	821	150	21	
U.S.N.M.	31493	Colima, Mexico	G. Xantus	Female	21-19	216		7	9	1-2	2+3+4	Adult		18	
U.S.N.M.	31494	Colima, Mexico	G. Xantus	Male	21-19-17	217		7	9	1-2	2+3+4 2+3+3	Adult			
U.S.N.M.	46552	Acambaro, Guanajuato, Mex.	E. W. Nelson	Male	21-20-21-23-21-19	206	42	8	10 9	1-2	2+3+5 2+3+4	810	.133	18	Type
A.M.N.H.	3525	Escuinapa, Sinaloa, Mex.	J. Batty	...	23-21-23-21-19	215	52	7	10 9	1-2	2+3+4		.130	14	
A.M.N.H.	3526	Escuinapa, Sinaloa, Mex.	J. Batty	Female	21-23-21-19	218	49	7	9	1-2	2+3+4		137	16	
A.M.N.H.	3527	Escuinapa, Sinaloa, Mex.	J. Batty	.....	21-19-17	220	53	7	9	1-2	2+3+4		130	16	
A.M.N.H.	3528	Escuinapa, Sinaloa, Mex.	J. Batty	Male	23-21-23-21-19	220	52	7	9	1-2	2+3+3 2+3+4	626	.142	13	
Acad Phila	3428	Mexico	Mr. Keating	Male	21-19-17	211	51	7	9	1-2	2+3+4	842	140	23	....

anteriorly and diverging somewhat posteriorly; other head shields normal for the genus.

Total length, 810 mm.; tail length, 108 mm.; tail, therefore, 13.3 per cent of total length. Sex, male.

Pattern of body (Plate I, Fig. 1) composed of 14 whitish rings about one and one-half scales in width above and about two on the first row of scales. They are continuous across the belly, and may be slightly mottled on the sides with darker. Bordering the whitish rings are annuli of black from three to four scales wide on the mid-dorsal line, about two on the first row of scales, and about one or two scutes in width on the belly. Between the pairs of black rings are broad encircling areas of red, from six to nine scales in width on the mid-dorsal line anteriorly, and three scales wide near the vent, but increasing to nine to eleven scales in width on the first row of scales anteriorly. On the tail are four whitish annuli separated by broad rings of black. On the belly in the red spaces posteriorly there is a little dark mottling, suggestive of *L. triangulum annulata* (Kennicott) in which these spaces are totally black.

The head is black as far back as a line from the posterior end of the parietal suture to the lower posterior angle of the fifth upper labial, except for a conspicuous mottling with lighter on all the plates anterior to the frontal. The chin and throat are whitish except for considerable black pigment on the anterior lower labials and a little on the chin shields. The first black ring is separated from the parietals by two scales and is slightly interrupted on the throat.

Remarks: The structural features of this form may be seen at a glance in the accompanying list of specimens examined.

The present material indicates that this is a fairly homogeneous form, characterized (*a*) by a low number of pairs of black annuli, separated by broad red interspaces, (*b*) by an absence of black tips on the red scales, and (*c*) by a light-colored snout mottled with darker.

While this color pattern seems to be constant on the west coast, it is very noticeable that toward the interior of Mexico some specimens have the spaces on the belly opposite the dorsal red areas partially or completely filled with black, presenting in this a striking approach to *L. triangulum annulata* (Kennicott). The snout, too, may be blacker, and the red interspaces between the pairs of black rings may be much narrower and strongly encroached upon by the latter.

Since in structural features this form is very close to *L. triangulum annulata*, it is believed that these similarities in pattern toward the interior of Mexico are sufficient evidence of intergradation with the latter.

Lampropeltis ruthveni, new species

Plate I, Figure 2

Diagnosis: A ringed form similar in coloration to *L. polyzona* Cope, *L. triangulum nelsoni* Blanchard, and *L. multicincta* (Yarrow). From *L. polyzona* it differs in the complete absence of black tips on the red and whitish scales, in the completely black head, and in the low number of ventral plates, 189. From *L. triangulum nelsoni* it differs principally in the higher number of annuli, 30, and the much narrower red rings, two to three scales in width. From *L. multicincta* it is distinguished by the low numbers of ventrals and annuli, by the fact that the black rings show scant, if any, tendency to overspread the red areas dorsally, and by the mottling of the yellow rings with darker, particularly on the sides.

Range: Patzcuaro, Michoacan, Mexico.

Type Specimen: United States National Museum No. 46558 (skin and head only); Patzcuaro, Michoacan, Mexico; collected by E. W. Nelson, August 2, 1892.

Description of Type Specimen: Ventrals, 189; anal single and entire; caudal scutes, 50 plus, divided (tip of tail missing); dorsal scale rows, 21 anteriorly, 23 on middle of body, and 19 posteriorly (formula therefore 21-23-21-19); upper labials, 8 on left side, 7 on right; lower labials, 9; 1 preocular, 2 postoculars; temporals somewhat irregular, about 2+3+4, the upper left anterior temporal much reduced; loreal longer than high; nasals injured on each side; anterior chin shields in contact with each other and with the first 4 lower labials; posterior chin shields shorter than the anterior and separated from each other by two or three small scales; other head shields normal for the genus.

Total length (tip of tail missing), about 745 mm.; tail length, 112 mm.

The dentition is as follows: maxillary teeth, 14 on the left side, 15 on the right, the last two distinctly enlarged; mandibular teeth, 14 on the left side, 13 on the right, decreasing slightly in size; palatine teeth, 13 on the left, 11 on the right; pterygoid teeth, 21 on the right side.

The color pattern (Plate I, Fig. 2) is composed of 24 whitish rings on the body and 6 on the tail. These rings are about one and one-half scales wide on the mid-dorsal line and two scales wide on the first row of scales; on the sides and on the belly, posteriorly, they are mottled with darker. Bordering the whitish rings are black annuli about two scales wide dorsally and one scale wide on the belly. The black rings are separated by red rings, two to three scales in width. The actual colors cannot be determined from so old a specimen, but there are indications that the whitish rings may have been suffused with pink.

The head is black nearly to the tips of the parietal shields, except for flecks of whitish on the lower portions of some of the upper labials. The chin is whitish except for some black on the first 5 or 6 of the lower labials. The first black ring begins about two scales behind the parietals and is continuous across the throat.

Remarks: The status and significance of this form, represented as it is by only a single specimen, must remain in doubt for the present. It appears, however, to be more closely allied to *L. multicincta* than to any other form in the genus.

PLATE I

FIG. 1.—*Lampropeltis triangulum nelsoni*, new subspecies. Color pattern of type specimen.

FIG. 2.—*Lampropeltis ruthveni*, now species. Color pattern of type specimen.

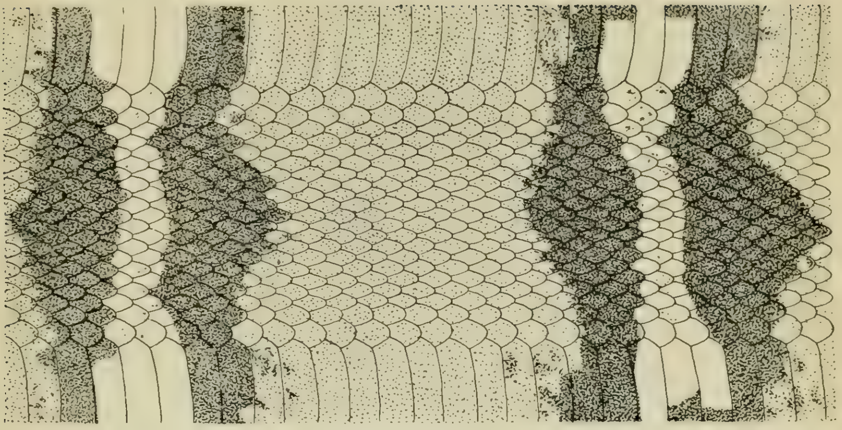


Figure 1

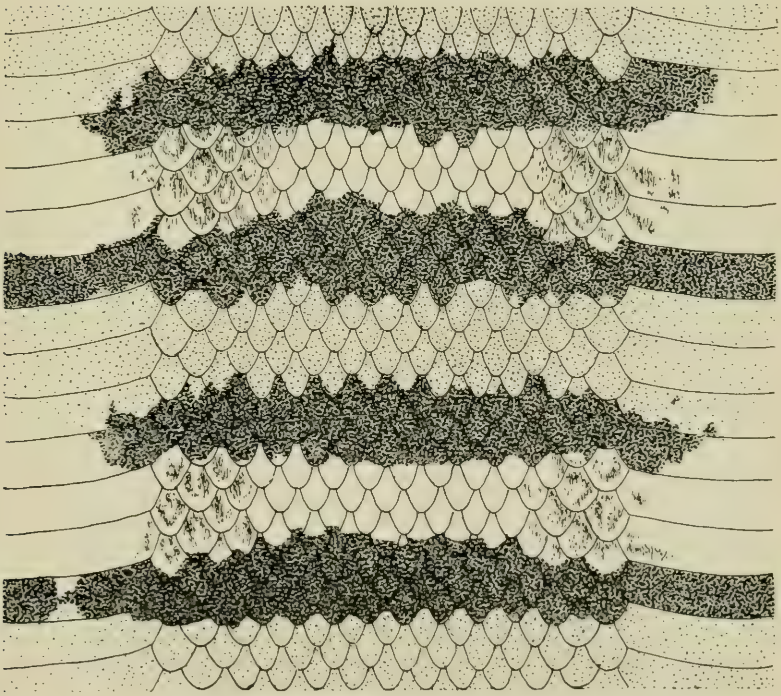


Figure 2

NUMBER 82 APRIL 28, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

ON A VERY PERFECT THORACIC SHIELD OF A LARGE LABYRINTHODONT IN THE GEOLOGICAL COLLECTIONS OF THE UNIVERSITY OF MICHIGAN

BY E. C. CASE

Remains of the large Labyrinthodonts of Triassic age are known from many localities within the United States, but very few specimens are more than fragments and reveal little of the anatomy. Branson (*Jour. Geol.*, XIII [1905], 568–94) has summarized the known material up to the date of his paper. In the summer of 1919, while examining the Dockum beds in western Texas, the author collected the nearly perfect clavicles and interclavicle (episternum) of a large form. As shown in the accompanying photograph, the plates are in such a perfect state of preservation as to show all the details of the lower surface. Only the extreme tips of the slender processes of the anterior ends of the plates and the scapular processes of the upper surface are lost.

The interclavicle is rhomboidal in form with the center of ossification and sculpture in the posterior half. The clavicles articulate with the interclavicle by overlapping suture at the posterior end; the contact was preserved by strong ridges and grooves. The clavicles are decidedly convex at the posterior end and the center of sculpture is presented laterally rather than downward. The loss of the broken tips of the slender processes of the anterior ends of the bones was slight and they did not meet in the median line; the intervening space must have been filled with cartilage. The scapular processes of the clavicles are represented by their base; the posterior end is about 12 mm. broad and the plates rapidly diminish to extreme thinness. The process lies in the posterior third of the clavicle and about 18 mm. within the outer edge. It is probable, but not certain, that the processes did not extend beyond the posterior edge of the bone.

A few typically stereospondylus vertebrae and fragments of skull bones have been found in the same locality.

The measurements are as follows:

	Mm.
Length of the interclavicle	328
Breadth of the interclavicle	290
Length of the clavicle	285
Breadth of the clavicle	165

The only specimens found in the United States with which this specimen can be compared are the interclavicle described by Lucas (*Proc. U.S. Nat. Mus.*, XVII [1904], 193–95) from the Triassic, five miles east of Tanner's Crossing, Little Colorado River, Arizona, and an imperfect interclavicle found near Tuckers Springs, on the road from Holbrook to Leupp, Arizona, which probably belongs to the same genus and species as Lucas' specimen. As shown in Plate III of Lucas' paper, his specimen resembles the one here described fairly closely but differs somewhat in proportions, being 430 mm. in length and 300 mm. in breadth; also the coarse reticulate sculpture of Lucas' specimen covers a proportionately larger part of the surface of the plate.

In comparison with the thoracic plates of *Metoposaurus diagnosticus* Frass from the lower Keuper of Hansweiler near Stuttgart

(*Paleontographica*, Band 36 [1889], pp. 137–58) certain small, perhaps only specific, but notable differences are apparent. The measurements of Frass' specimen are as follows:

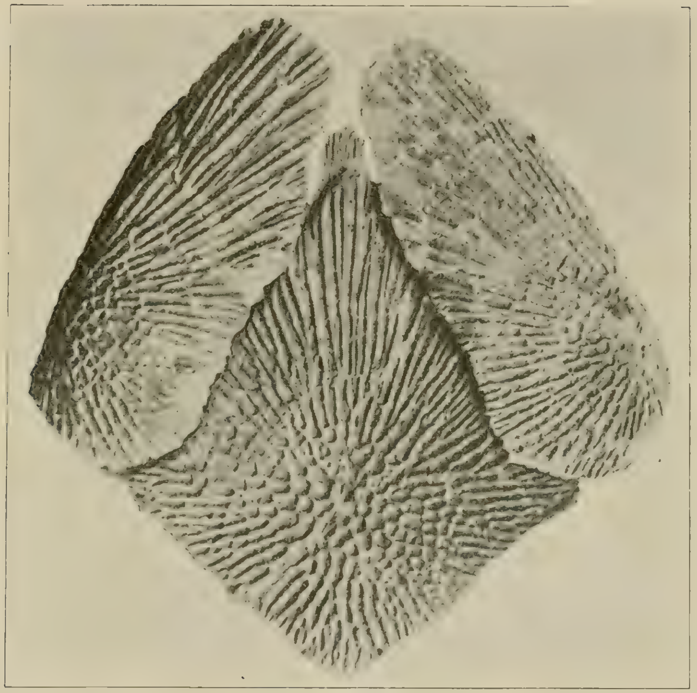
	Mm.
Length of the interclavicle	280
Breadth of the interclavicle	230
Length of the clavicle	300
Breadth of the clavicle	125

The clavicles articulate with the interclavicle by overlap on the lower side, but the outline of the suture is distinctly angular instead of broadly rounded; the clavicles meet in the median line for a distance of 120 mm.; the coarse reticulate sculpture is restricted to a very small area around the center of ossification.

So far as may be determined from the thoracic plates alone it appears that the specimen here described may be referred to the genus Metoposaurus, but that they must be placed in a separate species. For this species I take pleasure in proposing the name *M. jonesi* in grateful acknowledgment of the assistance afforded me by Clifford Jones, manager of the Swenson estate, upon which the specimen was found.

PLATE I

View of the lower surface of the thoracic plates of *Metoposaurus jonesi*, ×about $\frac{1}{6}$.



NUMBER 83 MAY 5, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

UNIVERSITY OF MICHIGAN

ANN ARBOR, MICHIGAN PUBLISHED BY THE UNIVERSITY

A NEW SPECIES OF CLINOSTOMUM

BY MARION ELIZABETH LAMONT
Zoological Laboratories, University of Wisconsin

The genus Clinostomum was first described by Rudolphi in 1809. He found some parasites in the esophagus of a heron, *Ardea purpurea*, and named them *Clinostomum heterostomum*. Leidy (1856) redescribed the genus as follows: Hermaphroditic flukes; genital pore with continguous male and female openings situated posterior to acetabulum. Oral sucker without tentacles or spines. Caudal extremity without retractile appendages. Intestine simple, bifurcate.

The described species are as follows:

Date	Observer	Genus	Species	Host
1809.....	Rudolphi	Clinostomum	heterostomum	Ardea purpurea
1819.....	Rudolphi	Clinostomum	complanatum	Ardea cinerea
1819.....	Rudolphi	Clinostomum	marginatum	Ardea cocoi
1899.....	Braun	Clinostomum	foliiforme	Ardea purpurea
1899.....	Braun	Clinostomum	detruncatum	Mycteria americana
1899.....	Braun	Clinostomum	sorbens	Tantalus loculator
1899.....	Braun	Clinostomum	dimorphum	Ardea cocoi
1899.....	Braun	Clinostomum	heluans	Ardea coerulea
1899.....	Braun	Clinostomum	lambitans	Ardea cocoi
1856.....	Leidy	Clinostomum	gracile	Pomotis vulgaris Perca flavescens
1885.....	Looss	Distomum	reticulatum	Siluris glanis
1888.....	Leidy	Distomum	galactosomum	Labrax lineatua

The trematodes described in this paper were collected by Dr. A. S. Pearse from a cormorant (*Phalacocorax vigua* Vieillot), killed on Lake Valencia, Venezuela, July 20, 1918. Fifty-seven specimens were scraped from the wall of the esophagus, to which they were attached by means of their suckers. All these belong to a single species, which appears to differ from all others described in the genus Clinostomum. It is distinguished by the great extent of the uterus, with corresponding genital pore, and by the position of cirrus intermediate between testes, hence the specific name *intermedialis*.

In the field the specimens were placed in corrosive sublimate solution for twenty-four hours and then transferred to 70 per cent alcohol. Some months later they were stained in carmine, alum cochineal, or haemotoxylin. After destaining and dehydrating, they were cleared in bergamot oil and mounted. A few specimens were embedded in paraffin, sectioned, and stained. For toto mounts, the carmine stain was most satisfactory; haemotoxylin and eosin gave the best contrast for the sectioned specimens.

Clinostomum intermedialis, new species

Type Specimen: Cat. No. 196, Museum of Zoology, University of Michigan; July 20, 1918; Collector, A. S. Pearse; taken from the esophagus of *Phalacocorax vigua* Vieillot.

Description: Some of the largest specimens were at least twice the size of the smaller individuals—an irregularity doubtless due to degree of maturity. The average length was 7 mm. and width 1.5 mm.

Generally, the body takes a regular oblong shape and a distinct neck may be present. The neck may be terete and narrow or flattened ventrally, depending upon the state of contraction in the body. There are no spines present, the body being entirely unarmed.

The two suckers are well developed. The anterior one is situated ventrally at the edge of the anterior margin. It is smaller than the posterior sucker, although it often appears larger on account of the protrusion of the surrounding body wall. In some specimens this anterior sucker was in a protruded state, and in others it was drawn down into the body so that it touched the pharynx. The acetabulum is situated ventrally in median line about one-third the length of the body from anterior end. This sucker is deep and has a large triangular opening, around which there is a thick muscular investment.

The digestive system consists of an oral sucker, pharynx, and two simple intestinal branches. The latter extend to the posterior part of the body where they end blindly. Although these coeca remain simple, they become much sacculated by numerous folds; especially in the region from the acetabulum to posterior testes these folds are much more complex.

An excretory pore at the extreme posterior portion of the body is connected with a reservoir-like region from which there are two main lateral branchings. These lateral branches extend forward, taking somewhat the same position as the branches of the intestinal coeca. These excretory branches cannot be traced in toto mounts, but in serial cross-sections the main lateral branches could be followed from caudal reservoir about half the length of the body—almost to the acetabulum. There seem to be many side branches from the main canals but the network is so delicate that it could not be followed.

The two large lobate testes are connected to a coiled cirrus by vasa efferentia. The testes are divided distinctly into three lobes situated in mid-line in the posterior third of the body. The vasa efferentia could be seen only at the point where they entered the cirrus sac. The cirrus sac is about half as large as one testis and has very thin walls. Within the walls of the cirrus sac there is a complicated tubular arrangement by which spermatozoa are conducted from vasa efferentia to the genital pore. Immediately back of the genital opening this convoluted tube becomes narrowed and straightened and finally connects with the penis which leads to the exterior or ventral surface, just below the opening from the uterus. The striking feature about this species is the fact that the cirrus sac lies between testes and not anterior to them.

The female reproductive system consists of an ovary, uterus which fills the region in the body between acetabulum and testes, bounded laterally by intestinal coeca, and vitelline glands with connecting ducts. The ovary is about half the size of the cirrus sac and lies between it and the posterior testis. Observing a specimen from ventral side, the ovary is equidistant between cirrus above, right branch of the intestine, and posterior testis. The ovary takes somewhat of an ovoid shape and lies a little to one side of the mid-line.

In toto mounts the uterus was so filled with eggs that the finer connecting ducts were obscure. The uterus and ovary seem to connect directly. After the uterus has made several convolutions in the area between the testes, it runs to the right and forward until it reaches the region between acetabulum and anterior testis where it makes two longitudinal loops, which are bounded laterally by intestinal coeca. In mature specimens the folds of the uterus are crowded with eggs and fill all available space between intestinal coeca, anterior testis, and acetabulum.

Most interesting is the way in which one branch of the uterus extends to the left and downward until it reaches the region of the cirrus sac so that it opens exactly above the opening of the male apparatus. In some mounts this terminal arm of the uterus was smaller and free from eggs, while in others eggs were present the entire length of the channel; the last egg might be lying at the edge of the genital opening. This shows the close proximity of the two genital openings.

The vitelline glands begin at the level of the acetabulum and extend to posterior part of the body. They are on either side of the coeca with many more on the outer side and only a few scattered on inner margin of intestinal branches. The genital field without vitellaria occupies all the space between acetabulum and excretory pore with coeca laterally—more than one-half the length of the body. The male reproductive system is largely confined to the lower third of the body while the female reproductive system extends nearly to the acetabulum.

Larva: Larval forms of *Clinostomum intermedialis* were found encysted in muscle at base of tail, under skin of operculum, and in the floor of the mouth of a catfish, *Rhamdia quelen* Quoy and Gaimard, collected by Dr. Pearse in the Rio Castaño, July 7, 1918. The general appearance and structure are like that of the adult. Length 6 mm.–7.5 mm., width 1 mm.–1.5 mm.

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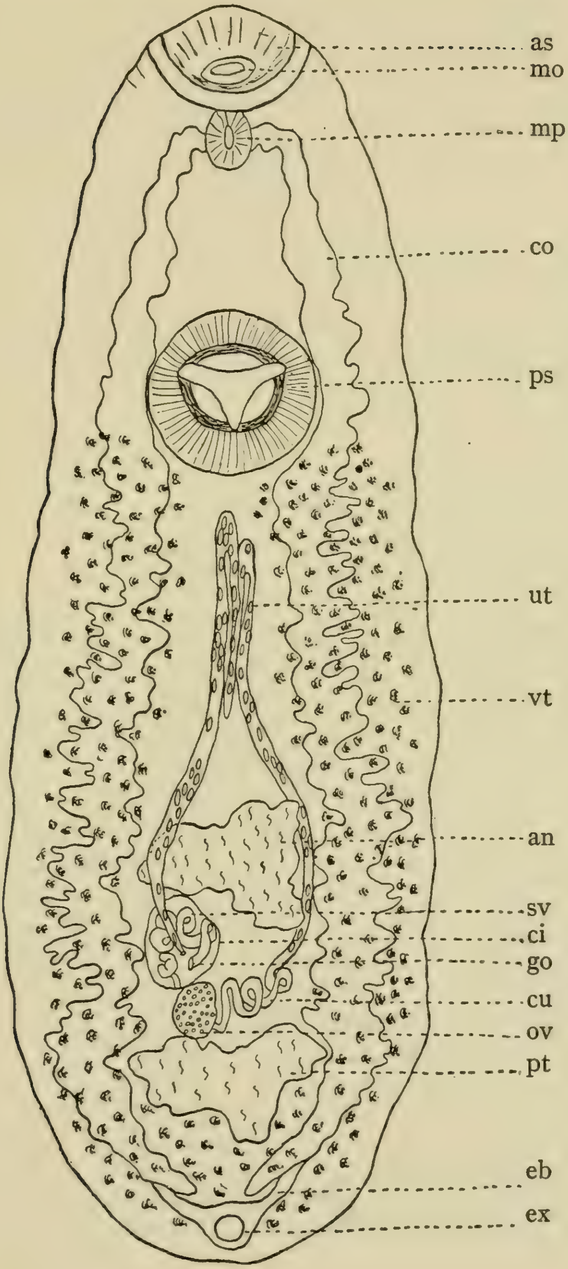
PLATE I

Clinostomum intermedialis: adult seen from ventral surface; *as*, anterior sucker; *an*, anterior testis; *ci*, cirrus sac; *co*, coeca; *cu*, coiled uterus; *eb*, excretory branch; *ex*, excretory pore; *go*, genital opening; *mo*, mouth opening; *mp*, muscular pharynx; *ov*, ovary; *ps*, posterior sucker; *pt*, posterior testis; *sv*, coiled seminal tube; *ut*, uterus; *vt*, vitelline glands.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Number 84 May 5, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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OBSERVATIONS UPON THE HABITS OF *ASCAPHUS TRUEI* STEJNEGER

By Helen Thompson Gaige

Our knowledge of the American representative of the Discoglossidae, *Ascaphus truei* Stejneger, is limited. Since its description by Stejneger in 1897 (*Proc. U.S. Nat. Mus.*, Vol. XXI, No. 1178) but five additional specimens have been recorded. The genotype, evidently a female, was captured at Humptulips, Chehalis County, Washington. In 1912, Van Denburgh, in his "Notes on Ascaphus" (*Proc. Cal. Acad. Sci.*, III, 259–64), reported the finding by Slevin of three males on Mount Ranier, Pierce County, Washington, at an elevation of 6,000 feet, and mentioned a fourth specimen, which had been destroyed, also taken on Mount Ranier at 4,861 feet. Van Denburgh's paper includes an excellent account of the skeleton and external appearance of the hitherto undescribed male, and apparently the only notes[1] upon the habits of the species.

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[1] Slevin found his specimens about the edge of a pool two or three feet deep in a small, slow-flowing stream. They jumped into the pool when disturbed and then dropped to the bottom where they remained motionless. They died a few hours after their capture, although they were kept in a well-ventilated can.

The fifth specimen is recorded in the "Distributional List of the Amphibians and Reptiles of California" (*Univ. of Cal. Pub. in Zool.*, Vol. 17, No. 10, pp. 127–208) by Grinnell and Camp, from the Siskiyou Mountains, northern California.

During the past four years the Museum of Zoology has received through its Washington collector, Phillips Putnam, nine specimens of this apparently rare Discoglossoid, collected on Mount Rose, the type locality of *Ranodon olympicus*. This summer, with his characteristic generosity to the Museum, Dr. Bryant Walker made possible an expedition to this interesting region, and F. M. Gaige and the writer were sent out to collect specimens and gather data upon the habits of the insect and amphibian faunas.[2]

Lake Cushman lies at the foot of Mount Rose, in the valley of the north fork of the Skokomish River, by road nine miles northwest of Hood's Canal. The valley is narrow, not more than a mile wide, and on either side the mountains rise abruptly. Below Lake Cushman most of the country has been logged, but the forest boundary begins at the lake and above this there is a dense coniferous forest to the very tops of the mountains, except for occasional small alpine meadows and areas which have been devastated by fire. The mountains are very precipitous, with numerous small, dashing streams, snow-fed and spring-fed, seldom more than a foot or so wide and a few inches deep. Collecting in these creeks was an arduous task; they were very swift, with many falls and miniature rapids, filled with rocks, with great tangles of devil's club and fallen trees along their banks, and the water was extraordinarily cold, usually under 40° even on the warmest days.

It was under the rocks in these little creeks that Ascaphus lived. They were found in almost all of the creeks that were worked intensively, from MacTaggert Creek (Mason County), which is between the north and south forks of the Skokomish, eight miles below Lake Cushman, to the creeks on Mount Steel (Jefferson County), twenty-five miles above, and from an elevation of 400 to 4,500 feet.

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[2] We were fortunate enough to secure quarters at Lake Cushman with William T. Putnam and his family, to whom we are deeply indebted for their kindly co-operation and hospitality.

The apparent rareness of the species may be accounted for by the fact that so little has been known about its habitat. As noted above, the only specimens reported upon have been found in the open. Only six specimens in the series of over a hundred which were acquired this summer were found on the banks of the streams, and only two were farther away from the water. One found them only by working slowly upstream and turning over every movable stone. Usually they either floated down the stream with the débris which was released when the stone under which they were resting was overturned, in which case it took quick action to catch them before they were out of sight, or they made no effort to move, and in the shifting lights and shadows their color so closely resembled a bit of fir bark or the small red stones which were abundant in the streams that they were distinguished with difficulty. Occasionally they were alert and slipped away like a shadow. When placed on land they were awkward and stupid in action and appearance and made little effort to escape. They were solitary; never more than one was found under a single stone and individuals were usually well separated in the stream. There was a decided element of chance to be reckoned with in collecting them, although they were not uncommon. A day's collecting, six to eight hours, seldom yielded more than five; on July 30 twenty-five were found in MacTaggert Creek in not more than three hours' work, while a week later our day's catch from the same creek numbered only four.

Specimens were found only in streams with densely forested banks with one exception; this was a little snow-fed creek on Mount Steel (4,500 feet) that ran through a small alpine meadow.

The banks of Laundry Creek, flowing into Lake Cushman, had been recently logged for some distance and no adults were taken on this cleared slope, though several were captured just above it. A low temperature and cold water are evidently necessary for the welfare of the species, for they died very quickly when placed in the sunlight. By putting fresh ice water on them at short intervals we were able to bring two, collected on August 8, to Michigan alive. They lived in an ice box until September 11, when they were preserved. They refused to eat in captivity. The stomach contents consist almost entirely of unidentifiable beetle elytra and spider fragments.

The appearance of the toads has been well described by Stejneger and Van Denburgh. The elongated gland on the body, mentioned in the type description, is frequently lacking or is broken up into a row of large glandules, and the pupil is a vertical, almost round oval. In live specimens there is a considerable range of color variation which is rather difficult to describe. The following color[3] notes were made on a live female: back cacao brown, light spot on head pinkish cinnamon, warts on sides and legs cinnamon buff, sides of head and body dark olive buff, below flesh color which was most distinct on chin and legs, belly densely spotted with mustard yellow. A live male differed from the female in having a citrine drab back and the warts cacao brown; the "tail" above was the color of the body with a dark stripe down either side, beneath darker. The ground color is most commonly old rose or brick red, but it may vary from cream white, through various shades of pink, gray, and brown to almost black. In the lightest and darkest specimens the pattern is fairly well obscured. The glandular ridge or row of glandules on the side is usually dark tipped with golden yellow; the dark spot on the head is almost triangular; the dark line on the wrist is seldom interrupted; the upper surface of the limbs is often set off from the lower by a dark line which merges gradually into the color beneath. The females are usually more brightly colored than the males.

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[3] Ridgway's Color Code.

Males are smaller than females and their legs are correspondingly longer. Twenty-five females varied from 33 to 50 mm. in length,[4] average 42.1+mm.; in this series the tibio-tarsal articulation marked the middle of the eye in three, the front of the eye in eighteen, and the nostril in four. The length to the "tail" of thirty-one males varied from 29 to 40 mm., average 35.4+mm.; the "tails" were from 3 to 9 mm. in length, average 5.4 mm.; the tibio-tarsal articulation reached to the front of the eye in four, to between the eye and the nostril in three, and to the nostril in twenty-four. Breeding males differ from the non-breeding in having an enormously enlarged (two to three times normal size) forearm and inner palmar tubercle; they have a white horny patch on the forearm where the inner palmar tubercle touches it when the arm is folded, and several have the inner palmar tubercle, the inner side of the first two fingers, and the round spot on the forearm covered with black; the underside of the "tail" is greatly congested; the underside of the forearm becomes gray thickly dotted with white.

That the breeding season is greatly prolonged is evidenced by an examination of the specimens. On June 27, July 2, July 8, July 30, August 22, August 24, and early in September, females contained large eggs and males possessed the enlarged forearm and anal region characteristic of the breeding season, while other males and females taken on the same dates are normal. The length of the breeding season is further borne out by the fact that larvae in all stages of development might be taken in the same stream on the same day. Two bunches of eggs were found under large stones in MacTaggert Creek on August 5. They were large

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[4] Measurements were made on specimens before they were preserved.

(capsule 8 mm., yolk 5 mm. in diameter), unpigmented, and laid in a rosary-like string twisted about to form a large circular mass which was attached to the lower surface of the stone. The eggs were brought in and development continued until August 13, when we were unable to get cold water for them and were forced to preserve them. At this time they showed no trace of pigmentation. The strings of eggs were so entangled that it was impossible to count them, but two of the females mentioned above contained thirty-five (sixteen, left side, seventeen, right) and forty-nine (twenty-four, left side, twenty-five, right) respectively.

The tadpoles are most curious, both in habits and appearance. They cling with the mouth to the stones in the creeks. One finds them in the swifter water and quieter pools alike, always with the tail pointing downstream. They may be in plain view or may appear after the stones have been moved. When disturbed they always swim upstream; when the water is so swift that it carries them down they quickly attach themselves to a rock. It is not unusual to find them clinging to rocks in the falls. They do not swim for great distances and were not observed moving about in the water when they had not been disturbed. Occasionally they wriggle about over the surface of the stone to which they are attached. It was sometimes possible to pick them up on a stone and transfer them to a bottle, or if one moved very quietly they could occasionally be induced to attach themselves to a finger, or they would adhere to the stone so firmly that it was difficult to dislodge them without injury. They seldom survived the trip home in a bottle; they would attach themselves to the glass above the water and were usually dead in an hour or so.

The immature Ascaphus looks not unlike a large Bufo tadpole, but the resemblance is purely superficial. It may be perfectly black or blackish brown thickly speckled with black. The eyes are all black, and there is no trace of iridescence in the coloration. The tail may be either all dark like the body, or obscurely or strongly spotted with creamy white; the tip may be creamy white with a dark band just behind it, and occasionally these light spots are rose or flame color. The tadpoles with the latter coloration are very conspicuous in the water.

The body is perfectly round; the tail is unusually long (even tadpoles with legs so well developed that they could hop about on land had tails twice as long as the body); the muscular portion of the tail is so wide that the crests are not conspicuous, and the latter are so pigmented that they are not translucent. When the animal is alive the crests are thickly covered with protruding pores which have the appearance of tiny tubercles. Three very striking characters, the dentition, and the positions of the spiraculum and anus, distinguish this tadpole from other known American forms. The mouth is very large and almost round. The upper beak is black edged with white, and there is no horny beak on the lower lip. The teeth are in 2-3 ridges above and 7-8-9-10 below; the upper series bear more than one row of teeth on each ridge. Below the first lower series there are often several ridges which either have no teeth or scattered patches of very small ones. The spiraculum is median, very inconspicuous, and is either just caudad to the lower lip or concealed beneath it. The median anal opening is concealed under the tip of a prominent flap which is attached to the body at its base and to the tail by a thin membrane.

Description of the Tadpole

The following detailed description of the tadpole has been prepared from specimen No. 53892, Museum of Zoology, University of Michigan; collected from Laundry Creek on June 25, 1919.

Length of body once and three-fourths its width and one-half the width of the tail; nostrils protruding, much nearer the eyes than the end of the snout, their distance from the eyes equal to the diameter of the latter; eyes small, on upper surface of the body, distance between them four-fifths of the distance between the nostrils; spiraculum median, a small slit just below the lower lip, much nearer the insertion of the hind limbs than the end of the snout. Anal opening median, concealed under the tip of a prominent flap which is connected with the body at its base, and folds back over the tail to which it is attached by a thin membrane. Tail three times as long as deep, tip rounded, upper and lower crests only slightly curved, the upper a little wider than the lower and not extending on the body; depth of the muscular part at the base seven-tenths the greatest total depth.

Mouth unusually large; upper beak black, with narrow white vertical line in the center and edged with white; no lower beak, the only trace of it being a tiny curved black patch below the upper beak; many series of minute papillae around the lower lip; conspicuous flaps above and on either side, the latter bordered by a single row of little papillae. Series of labial teeth $\frac{3}{10}$, occupying the entire width of the lips, the tenth lower series interrupted in the center; upper three ridges with more than one row of teeth, the first ridge several, the second three, the third two; on the lower lip the size of the teeth increases toward the beak.

Lines of muciferous crypts not very distinct. There is a short curving line on either side of the belly; another line starts on the upper lip, curves forward, following the line of the lip, and then turns sharply upward and backward along the lower part of the nose and eye; just back of the eye it is met by another line which curves around the eye and nostril above and meets the corresponding line from the other side on the center of the muzzle; from the juncture of the two lines behind the eye a single wavy line extends backward over the first third of the median line of the muscular portion of the tail, then curves upward and is continued on the upper edge of the muscular portion almost to the tip. Several little groups of the crypts, in no apparent pattern, can be distinguished on the back between the two wavy lines.

Color (in alcohol) of the body grayish white, spotted with black, growing gradually lighter on the sides; belly, deep cream color; tail, cream almost obscured by minute black spots; crests densely spotted with dark with the exception of part of the extreme edge and the tip, which are cream; legs, dark gray above, cream beneath; crypts, dark.

The measurements are as follows: length of body, 15 mm.; length of tail, 30 mm.; width of body, 12 mm.; length of mouth, 10 mm.; width of mouth, 8 mm.; distance between nostrils, 5 mm.; distance between eyes, 4 mm.; diameter of eye, 1 mm.; length of anal flap, 5 mm.; width of anal flap at base, 5 mm.; greatest depth of tail, 10 mm.; depth of muscular portion tail at base, 7 mm.

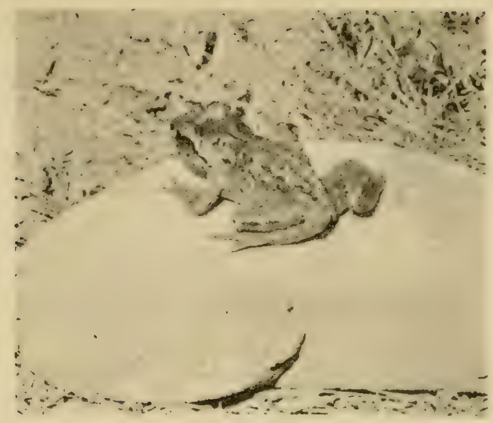
PLATE I

Ascaphus truei STEJNEGER

FIGS. 1 and 2.—Adult female.

FIG. 3.—Adult male.

FIG. 4.—Mouth of tadpole, ×6.



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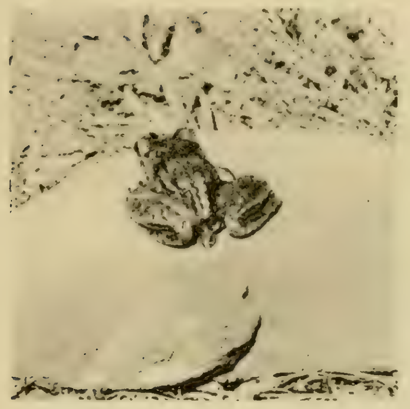

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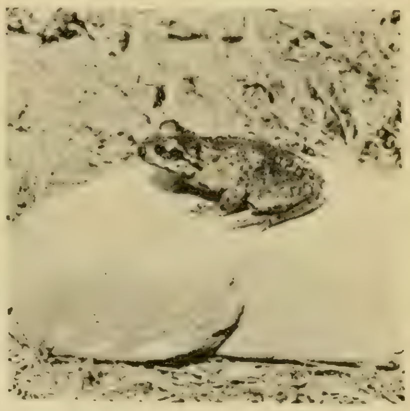

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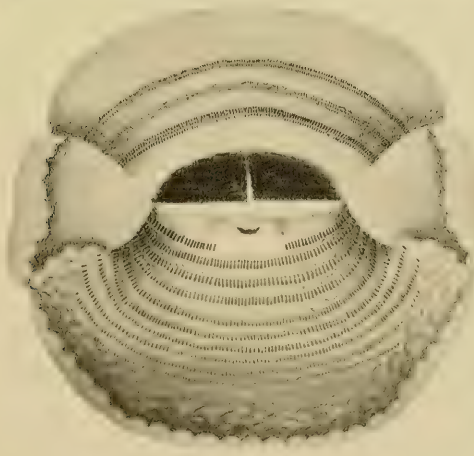

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THE LAND VERTEBRATE ASSOCIATIONS OF INTERIOR ALASKA

BY LEE RAYMOND DICE

INTRODUCTION

While serving as Deputy Fur Warden in the Alaska Fisheries Service during 1911 and 1912, many notes were secured on vertebrate habitats in interior Alaska. The present paper attempts to organize these notes, and is being published with the permission of the United States Bureau of Fisheries.

Interior Alaska was reached via Skagway and Dawson in July, 1911. Most of the time from then until February, 1912, was spent in the neighborhood of Tanana. In this time, however, a visit continuing through the month of August, 1911, was made to Fairbanks. In February and March, 1912, a portage was made by dog sled from Tanana to the head of the north fork of the Kuskokwim. Here a boat was constructed, in which the trip, beginning in June, was made to Bethel at the mouth of the Kuskokwim. During this journey a side trip of several weeks' duration was made to Takotna and its vicinity. From Bethel the Kuskokwim was again ascended in August to Kaltshak, from near which a portage was made to Russian Mission-on-the-Yukon. Here, in September, a river steamer was boarded, and from St. Michael passage was secured to Seattle.

The part of Alaska for which the land vertebrate associations are here described includes the interior of the territory north of the Alaska Range, south of the Endicott Mountains, and east of the Bering Sea tundra. This area is the Alaskan-Canadian faunal district of Nelson,[1] and is part of the Hudsonian Yukon district of Osgood.[2] The timbered parts would be considered in the Hudsonian life-zone, while the areas above timber-line are in the Arctic-alpine life-zone.

The land vertebrate associations of interior Alaska may be listed as follows:

Aquatic
Shore
Cut-bank
Cliff
Equisetum
Sedge
Niggerhead
Valley willow–alder
Poplar
White spruce–paper birch
Black spruce
Timber-line willow–alder
Blueberry–dwarf birch
Bare-ridge
Rocky-slope
Aerial
Burn
Cultivated-field
Edificarian

The descriptions of the habitats and associations here given are based mainly on the study of the regions near Fairbanks, near Tanana, and along the Kuskokwim River. A brief preliminary description of the region has already been given.[3]

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[1] E. W. Nelson, *Report upon Natural History Collections Made in Alaska*, 1887, p. 32.

[2] W. H. Osgood, *North American Fauna*, No. 19, 1900, 13–15.

[3] H. J. Christoffers and L. R. Dice, *U. S. Bur. Fish. Doc.*, No. 780, 1912, 100–111.

The interior of Alaska north of the Alaska Range is made up mostly of broad, nearly level valleys and massive, rounded hills which rise in many cases above timber-line into high, isolated domes. The older forest fringing the streams and extending over the sunny slopes of the hills is mostly of white spruce and Alaska paper birch, though on islands and on newly formed river bars there are thickets of willows and alders and some areas of poplars. The extensive forests of the region, however, are of stunted black spruce, which covers the lower hills and the greater parts of the valleys. In the valleys are numerous small lakes, each usually surrounded by a fringe of swamp. Growths of niggerheads and patches of blueberries occur also in the valleys. Timber-line at Tanana is at about 2,000 feet; above this are numerous patches of blueberries and dwarf birches, with occasional growths of scrub willows or alders. On the ridges are low growths of grass and a scanty growth of sphagnum. Talus and rock exposures are rather rare even on the higher slopes.

These conditions continue westward to the tundra along Bering Sea, which along the Yukon is met at Andreafski, and on the Kuskokwim at Bethel. Between the two rivers tundra extends farther inland, being found on the Kuskokwim-Yukon portage between Kaltshak and Russian Mission-on-the-Yukon.

To the lists of vertebrates found by the author in the different habitats have been added a number of records from Osgood[1] and Blackwelder.[2] The lists are very incomplete, but no species has been included in a list without positive evidence of its occurrence in that particular habitat within the region.

Mr. Edward A. Preble and Dr. H. C. Oberholser gave much help in working up the taxonomy of the mammals and birds respectively. Dr. Frederick V. Coville assisted with the plant

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[1] W. H. Osgood, *op. cit.*, 22–45, and *North American Fauna*, No. 30, 1909, 13–44.

[2] Eliot Blackwelder, *Auk*, XXXVI, 1919, 57–64.

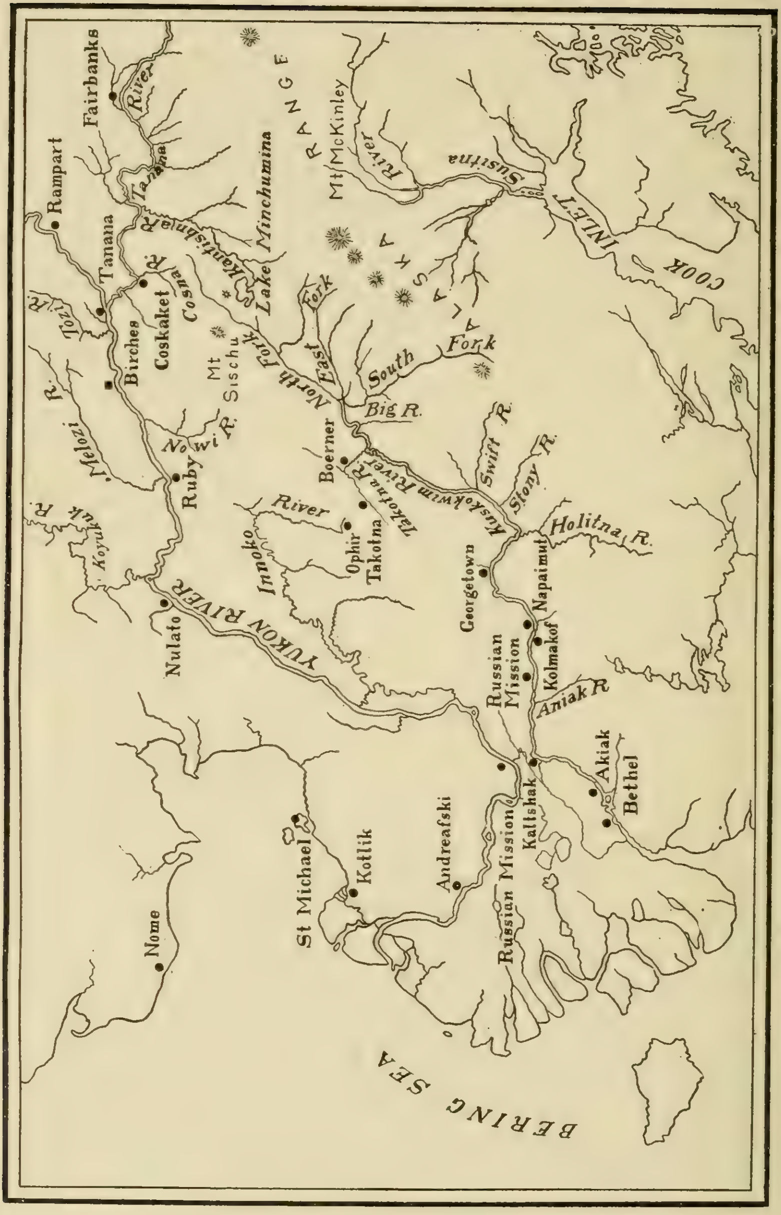

FIG. 1.—Map of west-central Alaska. One inch equals 120 miles

names. However, all the plant specimens collected spoiled during the wet summer of 1912, and the names used are based entirely on field identifications. The whole of the work would have been impossible without the co-operation of Dr. Barton W. Evermann, then chief of the Alaska Fisheries Service.

CLIMATIC CONDITIONS

The climate of interior Alaska is sub-arctic; there is a long winter, with temperatures constantly below freezing and usually below zero, and a short summer, in which the days are often hot, but with nights as a rule cold. Table I gives a summary of meteorologic data for several interior stations from records furnished by the United States Weather Bureau. The records for lowest temperature, average snowfall, and average number of rainy or snowy days are taken from charts which evidently are somewhat old. A noticeable feature is the close similarity in the records from the different stations. Nearly uniform climatic conditions are found over nearly the whole of the interior.

TABLE I

METEOROLOGICAL RECORDS OF INTERIOR ALASKA

	Elevation, Approximate	Years	Temperatures		Precipitation, Mean	Average Snowfall	Average Number Rainy or Snowy Days
			Mean	Lowest			
Allakaket	1000 ft.	8	17.2°F	......	11.68 in.	....	....
Eagle	834	15	24.0	-75°F.	11.68	48.3 in.	85
Fort Yukon	700	....	......	-68	....	45.6	75
Fairbanks	600	9	24.0	-65	11.44	50.8	91
Rampart	500	10	22.0	-68	10.25	51.4	92
Tanana	500	16	22.0	-76	11.97	48.6	79

Throughout the region the variations in temperature are extreme. On June 27, 1915, a temperature of 100° F. was officially recorded at Fort Yukon, and temperatures of 90° are common in summer at many places in the interior. The recorded extreme limits of temperature range are from -76° to 100° F., a range of 176°, and yearly ranges of over 150° are normal. The daily range also is often great, especially in summer, and killing frosts may occur in any month of the year.

To indicate the climatic conditions during the various seasons, the monthly averages of temperature and precipitation are given for Tanana (Table II). A noticeable feature is the scanty amount of precipitation.

TABLE II

TANANA, MONTHLY AVERAGES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature (F.).....	−16.0°	−5.0°	8.0°	23.0°	44.0°	58.0°	59.0°	52.0°	39.0°	22.0°	−2.0°	−13.0°	22.0°
Precipitation in inches.	.77	.62	.61	.20	.95	.73	2.01	2.42	1.18	1.04	.79	.65	11.97

At Tanana in 1911 the leaves on the birches and poplars began to turn yellow in late August, and by late September nearly all the leaves had fallen. A light snow fell in the Yukon Valley on October 2, and the surface of the ground had frozen solid by October 20. Ice began to run in the Yukon on October 25, and the river froze over on November 8, at a temperature of about -14° F. Numerous light snows fell during October and November, but the snow did not become deep enough to require snowshoes until the middle of December. However, the snow was said to have come late that year.

In the spring of 1912, at the head of the north fork of the Kuskokwim, a thawing temperature was first reached on March 22, though the snow had by that time partly melted off the exposed slopes. The snow melted slowly, but was almost entirely gone by April 26; the ground, however, remained frozen for several weeks longer. Willows were in bloom on April 29. The ice in the river, which of course was small at this place, broke up on April 26. During the second week in May the willows and birches began to send out vigorous buds, and small leaves had appeared by May 15. A week later they were well leafed out.

VERTEBRATE HABITATS AND ASSOCIATIONS

Aquatic habitat and association:

Rana cantabrigensis latiremis. Northern wood frog. Summer.
Colymbus holbœlli. Holboel grebe. Summer.
Gavia pacifica. Pacific loon. Summer (Blackwelder).
Gavia stellata. Red-throated loon. Summer.
Anas platyrhynchas. Mallard. Summer.
Mareca americana. Baldpate. Summer.
Nettion carolinense. Green-winged teal. Summer.
Dafila acuta tzitzihoa. Pintail. Summer.
Clangula clangula americana. Golden-eye. Summer.
Charitonetta albeola. Bufflehead. Summer.
Harelda hyemalis. Old-squaw. Summer.
Histrionicus histrionicus pacificus. Harlequin duck. Summer.
Oidemia perspicillata. Surf scoter. Summer.
Anser albifrons gambeli. White-fronted goose. Summer.
Branta canadensis hutchinsi. Hutchins goose. Summer.
Lobipes lobatus. Northern phalarope. Summer.
Pandion haliaëtus carolinensis. Fish hawk. Summer.
Streptoceryle alcyon caurina. Western kingfisher. Summer.
Mustela vison ingens. Alaska mink.
Lutra canadensis canadensis. Canada otter.
Fiber zibethicus spatulatus. Northwestern muskrat.
Castor canadensis canadensis. Canada beaver.
Alces gigas. Alaska moose.

In interior Alaska there are two principal rivers, the Yukon and the Kuskokwim, each fed by numerous tributaries, some of which are of large size. Small streams and creeks abound, and most of these flow throughout the year, though they are frozen over in winter. Those streams which flow from the region of active glaciers on the north side of the Alaska Range carry much fine mud in suspension during the summer, and for this reason the Yukon and the main Kuskokwim are muddy streams. The smaller streams draining lakes and swamps carry sediment only during freshets, but they carry much organic matter, enough sometimes to give the water a brownish or blackish color. Sloughs in all stages of filling abound along the larger valleys.

Lakes are common in the valleys, and are especially abundant along the upper parts of the Kuskokwim. Most of the lakes are small and shallow, though a few, Lake Minchumina, for example, are a number of miles across and are deep in parts.

The shallower lakes usually contain an abundance of water lilies and other aquatic plants, but the rivers and sloughs seldom contain much aquatic vegetation.

This habitat is used by a number of birds and by several mammals for shelter from enemies. It is the feeding-place also of a few birds and of the mink and otter. The moose enters the lakes in summer for protection from mosquitoes. During the breeding season nearly every small lake is the home of at least one pair of breeding ducks, while the larger lakes shelter numerous pairs of ducks and also geese and other aquatic birds.

Shore habitat and association:

Larus hyperboreus barrovianus. Glaucous gull. Summer.
Larus brachyrhynchus. Short-billed gull. Summer.
Larus philadelphia. Bonaparte gull. Summer.
Anas platyrhynchas. Mallard. Summer.
Nettion carolinense. Green-winged teal. Summer.
Histrionicus histrionicus pacificus. Harlequin duck. Summer.
Anser albifrons gambeli. White-fronted goose. Summer.
Branta canadensis hutchinsi. Hutchins goose. Summer.
Olor columbianus. Whistling swan. Summer.
Grus canadensis canadensis. Little brown crane. Summer.
Lobipes lobatus. Northern phalarope. Summer.
Pisobia minutilla. Least sandpiper. Summer.
Totanus melanoleucus. Greater yellowlegs. Summer.
Totanus flavipes. Yellowlegs. Summer.
Tringa solitaria cinnamomea. Western solitary sandpiper. Summer.
Actitis macularia. Spotted sandpiper. Summer.
Charadrius semipalmatus. Semipalmated plover. Summer.
Bonasa umbellus yukonensis. Yukon ruffed grouse. Resident.
Euphagus carolinus. Rusty blackbird. Summer.

Seiurus noveboracensis notabilis. Grinnell water-thrush. Summer.
Hylocichla aliciæ aliciæ. Gray-cheeked thrush. Summer.
Ixoreus nævius meruloides. Northern varied thrush. Summer.
Saxicola œnanthe œnanthe. Wheatear. Summer.
Sorex tundrensis. Tundra shrew (Osgood).
Ursus americanus americanus. Black bear.
Vulpes alascensis alascensis. Alaska red fox.
Mustela vison ingens. Alaska mink.
Lutra canadensis canadensis. Canada otter.
Microtus xanthognathus. Chestnut-cheeked vole (Osgood).
Fiber zibethicus spatulatus. Northwestern muskrat.
Erethizon epixanthum myops. Alaska porcupine.
Castor canadensis canadensis. Canada beaver.
Lepus americanus macfarlani. Macfarlane snowshoe hare.
Alces gigas. Alaska moose.

The shore habitat comprises the areas of nearly bare mud, sand, and gravel found along the shores of the streams and lakes. It is often only a narrow strip a few feet in width, but along the larger rivers it may in places expand into bars many rods in width and miles in length. The habitat is washed over at periods of high water, especially in the spring, and as a rule supports little vegetation. A few scattered willows may occur, and sometimes scattered herbaceous plants; rarely a thin growth of horsetails is found· In parts of streams and in sloughs where the current is sluggish and where the shore habitat is composed mostly of wet mud bars, there is a tendency for these to become rapidly covered by horsetails, sedges, willows, and other plants, and so to pass into the swamp-meadow or willow-alder type of habitat.

The shores are the feeding- and resting-places of a number of species of birds; and they are also used by several species of mammals as routes of travel and as hunting places.

Cut-bank habitat and association:

Streptoceryle alcyon caurina. Western kingfisher. Summer, breeding.
Tachycineta thalassina lepida. Northern violet-green swallow. Summer (Blackwelder).
Riparia riparia riparia. Bank swallow. Summer, breeding.
Lemmus yukonensis. Yukon lemming (Osgood).
Microtus mordax. Merriam vole (Osgood).
Citellus osgoodi. Yukon ground squirrel.

In many places the streams are undercutting their banks, leaving a nearly vertical exposure of earth and sometimes gravel. The exposure of cut bank is usually from ten to fifteen feet in height, but where the stream is cutting against a hill it may be much higher.

The soft dirt banks are the nesting-places of several species of birds, and the burrows of a few mammals are found here also.

Cliff habitat and association:

Aquila chrysaëtos. Golden eagle. Summer, breeding (Osgood, Blackwelder).
Falco peregrinus anatum. Duck hawk. Summer, breeding.
Falco columbarius columbarius. Pigeon hawk. Summer.
Sayornis sayus. Say phoebe. Summer (Osgood).
Corvus corax principalis. Northern raven. Summer, breeding (Osgood).
Petrochelidon lunifrons lunifrons. Cliff swallow. Summer (Blackwelder).
Tachycineta thalassina lepida. Northern violet-green swallow. Summer, breeding (Osgood, Blackwelder).

Rocky cliffs occur frequently along the larger rivers, especially where these wash against the base of a hill or mountain. Cliffs are also found sparingly in the higher parts of the hills and in a few places in the lowlands, notably where an outcrop of harder rock occurs. These cliffs are usually exposures of bare rock, somewhat broken into ledges and sometimes with little gullies coming part way down. A few herbs, shrubs, and small trees may, in the lowlands, grow on the ledges and in the gullies.

The cliffs are the nesting-places of a number of birds, but no trapping was done in the habitat and I have no records for mammals.

Equisetum habitat and association:

Anas platyrhynchas. Mallard. Summer.
Nettion carolinense. Green-winged teal. Summer.
Dafila acuta tzitzihoa. Pintail. Summer.
Anser albifrons gambeli. White-fronted goose. Summer.
Buteo lagopus sancti-johannis. Rough-legged hawk. Summer.
Synaptomys dalli. Dall lemming-vole.
Evotomys dawsoni dawsoni. Dawson red-backed vole.

Microtus pennsylvanicus drummondi. Drummond vole.
Fiber zibethicus spatulatus. Northwestern muskrat.
Alces gigas. Alaska moose.

Equisetum in practically a pure growth is often found growing extensively on wet mud bars along the rivers, and was especially noticeable along the lower Kuskokwim above Bethel. But the habitat is best developed about shallow lakes. Here horsetails may extend out into the lake until the water reaches a depth of about a foot, and they also occupy the adjacent low ground. In favorable places they form almost a pure stand in a belt ten to twenty yards or more in width.

Sedge habitat and association:

Rana cantabrigensis latiremis. Northern wood frog. Summer.
Anas platyrhynchas. Mallard. Summer.
Nettion carolinense. Green-winged teal. Summer.
Marila affinis. Lesser scaup. Summer (Osgood).
Lobipes lobatus. Northern phalarope. Summer.
Gallinago delicata. Wilson snipe. Summer.
Tringa solitaria cinnamomea. Western solitary sandpiper. Summer.
Euphagus carolinus. Rusty blackbird. Summer.
Melospiza lincolni lincolni. Lincoln sparrow. Summer.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink.
Synaptomys dalli. Dall lemming-vole (Osgood).
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Microtus pennsylvanicus drummondi. Drummond vole.
Microtus xanthognathus. Yellow-nosed vole (Osgood).
Fiber zibethicus spatulatus. Northwestern muskrat.
Alces gigas. Alaska moose.

Sedges occur to some extent on the river banks, and sometimes grasses are found along the streams at the edge of the forest. Around lakes a belt of sedges is often found surrounding the belt of horsetails, but around lakes containing much decaying vegetation horsetails are not well developed, and the sedges reach the water's edge, and may sometimes be partly submerged. The belt of sedges is often ten to twenty yards in width and may in favorable situations be much wider. In a filled-in swamp sedges may cover an area many acres in extent.

Niggerhead habitat and association:

Lagopus lagopus albus. Willow ptarmigan. Resident.
Sorex personatus arcticus. Arctic shrew.
Sorex tundrensis. Tundra shrew.
Microsorex eximius. Alaska microsorex.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink.
Lemmus yukonensis. Yukon lemming.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Microtus pennsylvanicus drummondi. Drummond vole.
Microtus operarius endœcus. Interior vole.
Alces gigas. Alaska moose.

Extensive areas of niggerheads occur in parts of the valleys where drainage is poor. These niggerheads are tussocks of tough grass, which elongate each year until the head may be several feet above the ground. The heads usually grow close together, there being usually a free space of six to twelve inches between the pedestals. The ground is bare and moist. Willows, alders, blueberries, and other shrubs when present grow thinly; or in places the willows or the blueberries increase sufficiently to dominate, giving rise to a different type of habitat.

Niggerheads also occur on nearly level slopes up to and above timber-line. In such places a growth of blueberries and dwarf birch, with sphagnum growing between the niggerheads, is commonly dominant and areas of pure niggerheads are infrequent.

On the somewhat better-drained ground around the belt of sedges surrounding a lake, grasses, mostly in tussocks of the niggerhead type, are common and may form a distinct belt. Thickets of willows and alders frequently invade this belt from the edge of the forest, and isolated thickets of these shrubs may appear in the midst of a large area of niggerheads.

In time the niggerheads of poorly drained situations seem to be invaded by sphagnum, which ultimately fills the interstices between the heads, and, if below timber-line, black spruces appear, and finally the area becomes a black spruce forest.

The vertebrates listed from this habitat are recorded from the larger valleys in areas of typical niggerheads nearly free from sphagnum and unmixed with any considerable amount of shrubs.

Valley willow–alder habitat and association:

Bonasa umbellus yukonensis. Yukon ruffed grouse. Resident.
Lagopus lagopus albus. Willow ptarmigan. Resident.
Lagopus rupestris rupestris. Rock ptarmigan. Resident.
Buteo lagopus sancti-johannis. Rough-legged hawk. Summer.
Bubo virginianus lagophonus. Northwestern horned owl. Resident.
Empidonax trailli alnorum. Alder flycatcher. Summer (Osgood, Blackwelder).
Perisoreus canadensis fumifrons. Alaska jay. Resident.
Loxia leucoptera. White-winged crossbill. Summer.
Acanthis hornemanni exilipes. Hoary redpoll. Winter.
Acanthis linaria linaria. Redpoll. Resident, breeding.
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer.
Zonotrichia gambeli. Gambel sparrow. Summer.
Zonotrichia coronata. Golden-crowned sparrow. Summer (Osgood).
Spizella monticola ochracea. Western tree sparrow. Summer.
Junco hyemalis hyemalis. Slate-colored junco. Summer.
Melospiza lincolni lincolni. Lincoln sparrow. Summer (Osgood).
Passerella iliaca iliaca. Fox sparrow. Summer.
Vermivora celata celata. Orange-crowned warbler. Summer.
Dendroica æstiva rubiginosa. Alaska yellow warbler. Summer, breeding (Osgood, Blackwelder).
Dendroica coronata hooveri. Myrtle warbler. Summer.
Seiurus noveboracensis notabilis. Grinnell water-thrush. Summer.
Wilsonia pusilla pusilla. Wilson warbler. Summer.
Penthestes hudsonicus hudsonicus. Hudsonian chickadee. Resident.
Regulus calendula calendula. Ruby-crowned kinglet. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Ixoreus nævius meruloides. Northern varied thrush. Summer.
Sorex personatus arcticus. Arctic shrew.
Sorex obscurus obscurus. Mountain shrew.
Ursus americanus americanus. Black bear.
Vulpes alascensis alascensis. Alaska red fox.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink.
Lutra canadensis canadensis. Canada otter.
Lynx canadensis. Canada lynx.
Synaptomys dalli. Dall lemming-vole.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Microtus pennsylvanicus drummondi. Drummond vole.
Microtus operarius endœcus. Interior vole.

Erethizon epixanthum myops. Alaska porcupine.
Citellus osgoodi. Yukon ground squirrel (Osgood).
Castor canadensis canadensis. Canada beaver.
Lepus americanus macfarlani. Macfarlane snowshoe hare.
Alces gigas. Alaska moose.

On the mud bars along the larger rivers and at the outer edge of the grassy areas about lakes a growth of willows, *Salix*, is likely to spring up. Alders, *Alnus*, occur sometimes mixed with the willows and rarely form pure stands, seeming to represent mostly a stage following the willows. Willows and alders rarely form isolated thickets in patches of niggerheads. The ground under the growth of willows and alders is often bare, but may in wet situations on mud bars be covered by horsetails, or in the drier areas about lakes by grasses and other herbs. An older growth of willows may attain a treelike form, and rarely alders also attain considerable size; but old growths of either willow or alder are rare, for these formations are rapidly replaced by poplars and by the more permanent types of forest.

Thickets of willows and of alders, the two sometimes mixed together, occur along the smaller creeks up to timber-line, there connecting with the timber-line willow-alder habitat, which is here considered as distinct. The distinction between the willow and alder habitats of the lowlands and highlands is, however, not sharp, and subsequent observations may show that the two should be combined.

Poplar habitat and association:

Colaptes auratus borealis. Boreal flicker. Summer (Osgood).
Vulpes alascensis alascensis. Alaska red fox.
Microtus xanthognathus. Yellow-nosed vole (Osgood).

Forests of poplar, *Populus candicans*, occur in the valley of the Yukon, where they are best developed on islands. Fringes of poplars between the willow-alder thickets and white spruce–paper birch forest may often be seen. Along the Kuskokwim the poplar seems to be much less abundant.

As found on islands at Tanana poplars thickly cover many acres with nearly a pure stand, the trunks often reaching a diameter of eighteen inches or more. Under an old forest of this kind there are many decaying limbs and logs, but there is little herbaceous vegetation. Old trees of willow and scrub alders may often be found in the forest; there are also numerous young paper birches and white spruces, and it seems certain that the poplars will eventually be replaced by the white spruce–paper birch type of forest.

Tracks of mice and shrews and of red fox were seen in a poplar forest near Tanana in winter, but no trapping was carried on in this habitat and no opportunity was found to study a well-developed poplar forest in summer. However, a few records from Osgood are available. The vertebrates of the habitat probably differ little from those of the white spruce–paper birch forest.

A grove of aspens, *Populus tremuloides*, was noted near timberline in a cove on the hills north of Tanana, and several isolated trees were seen on the shores of a small lake near the head of the north fork of the Kuskokwim. The species was also found on the divide toward Lake Minchumina, some of the trees being fair sized, but on the top of a wind-swept hill they occurred in a thick growth of stunted shrubs not over two or three inches in diameter and about ten feet tall. It is probable that aspens occur much more frequently than these notes would indicate. No records of vertebrates were secured from the aspens.

White spruce–paper birch habitat and association:

Canachites canadensis osgoodi. Alaska spruce grouse. Resident.
Bonasa umbellus yukonensis. Yukon ruffed grouse. Resident, breeding.
Buteo lagopus sancti-johannis. Rough-legged hawk. Summer, breeding (Osgood).
Aquila chrysaëtos. Golden eagle. Summer.
Pandion haliaëtus carolinensis. Fish hawk. Summer, breeding.
Bubo virginianus lagophonus. Northwestern horned owl. Resident.
Surnia ulula caparoch. Hawk owl. Resident.
Streptoceryle alcyon caurina. Western kingfisher. Summer.

Dryobates villosus septentrionalis. Northern hairy woodpecker. Summer.
Picoides americanus fasciatus. Alaska three-toed woodpecker. Resident.
Colaptes auratus borealis. Boreal flicker. Summer.
Nuttallornis borealis. Olive-sided flycatcher. Summer.
Perisoreus canadensis fumifrons. Alaska jay. Resident.
Corvus corax principalis. Northern raven. Resident.
Loxia leucoptera. White-winged crossbill. Resident.
Acanthis hornemanni exilipes. Hoary redpoll. Winter.
Acanthis linaria linaria. Redpoll. Resident, breeding.
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer.
Zonotrichia gambeli. Gambel sparrow. Summer.
Spizella monticola ochracea. Western tree sparrow. Summer.
Junco hyemalis hyemalis. Slate-colored junco. Summer.
Passerella iliaca iliaca. Fox sparrow. Summer.
Dendroica coronata hooveri. Myrtle warbler. Summer.
Seiurus noveboracensis notabilis. Grinnell water-thrush. Summer.
Wilsonia pusilla pusilla. Wilson warbler. Summer.
Penthestes hudsonicus hudsonicus. Hudsonian chickadee. Resident.
Regulus calendula calendula. Ruby-crowned kinglet. Summer.
Hylocichla ustulata swainsoni. Olive-backed thrush. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Ixoreus nævius meruloides. Northern varied thrush. Summer.
Sorex personatus arcticus. Arctic shrew.
Ursus americanus americanus. Black bear.
Vulpes alascensis alascensis. Alaska red fox.
Martes americana actuosa. Alaska marten.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink.
Lutra canadensis canadensis. Canada otter.
Lynx canadensis. Canada lynx.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Erethizon epixanthum myops. Alaska porcupine.
Sciurus hudsonicus hudsonicus. Northern red squirrel.
Glaucomys sabrinus yukonensis. Yukon flying squirrel.
Lepus americanus macfarlani. Macfarlane snowshoe hare.
Alces gigas. Alaska moose.

On the better-drained parts of the river valleys, especially along the edges of the streams, and on many of the lower slopes having a southern exposure, may be found a mixed forest of which the dominant trees are the white spruce, *Picea canadensis*, and the Alaska paper birch, *Betula alaskana*. Other trees found in this forest are the willows, *Salix*, poplar, *Populus candicans*, a red birch, perhaps a color phase of *Betula alaskana*, and black spruce, *Picea mariana*. A considerable amount of underbrush chiefly of alder, *Alnus*, occurs. If the shade is not too heavy there are also grasses and a few shrubs such as the high-bush cranberry, *Viburnum pauciflorum*, trailing juniper, *Juniperus sibirica*, and bearberry, *Arctostaphylos uva-ursi*.

The altitudinal range of this type of forest is usually not high, though on the warm and well-drained southern slopes of Mount Sischu a burned forest of white spruce and birch was found to have formerly extended up to timber-line.

Nearly pure forests of Alaska paper birch occur on some warm slopes. The trees in these forests are quite uniform in height and apparently in age, and vary from six to twelve inches in diameter, with a height of about sixty feet. Such forests are particularly common on the slopes near Lake Minchumina, where they have apparently developed following a fire. The ground under the birches is usually covered by a heavy growth of bearberry. In this type of forest young white spruces often occur, and the whole forest is seemingly a younger stage in the development of a white spruce forest.

A few groves of nearly pure white spruces occur along the stream margins in the broader valleys. These groves are usually small in extent, probably because the streams, undercutting their banks in their meanders across the valleys, do not give time to develop any considerable extent of white spruce forest to full maturity. The trees even in the larger groves seldom have a greater diameter than two feet. The forest floor under the white spruces is either nearly bare of vegetation and covered by spruce needles, or in open forest a growth of grass may be present.

The occurrence of a pure forest of either paper birch or white spruce is rare, the common condition being a mixed forest with these two species represented in varying proportions.

Black spruce habitat and association:

Canachites canadensis osgoodi. Alaska spruce grouse. Resident.
Lagopus lagopus albus. Willow ptarmigan. Resident.
Lagopus rupestris rupestris. Rock ptarmigan. Winter.
Pediœcetes phasianellus phasianellus. Sharp-tailed grouse. Winter.
Surnia ulula caparoch. Hawk owl. Resident.
Perisoreus canadensis fumifrons. Alaska jay. Resident.
Corvus corax principalis. Northern raven. Resident.
Pinicola enucleator alascensis. Alaska pine grosbeak. Autumn.
Loxia leucoptera. White-winged crossbill. Winter.
Acanthis linaria linaria. Redpoll. Winter.
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer.
Junco hyemalis hyemalis. Slate-colored junco. Summer, breeding (Osgood).
Passerella iliaca iliaca. Fox sparrow. Summer, rare.
Bombycilla garrula pallidiceps. Bohemian waxwing. Spring.
Hylocichla aliciæ aliciæ. Gray-cheeked thrush. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Ixoreus nævius meruloides. Northern varied thrush. Summer.
Sorex personatus arcticus. Arctic shrew.
Ursus americanus americanus. Black bear. Summer.
Vulpes alascensis alascensis. Alaska red fox.
Martes americana actuosa. Alaska marten.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink. Winter, rare.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Sciurus hudsonicus hudsonicus. Northern red squirrel.
Lepus americanus macfarlani. Macfarlane snowshoe hare.
Alces gigas. Alaska moose.
Rangifer stonei. Stone caribou.

The forests which cover the low hills and the greater part of the valleys in interior Alaska are mainly composed of black spruce, *Picea mariana.* The trees are mostly stunted, growing from six to twenty feet high and having trunks only from one to six inches in diameter, though in exceptionally favorable situations, mostly in white spruce forest, the black spruce may reach a trunk diameter of twelve inches. The tamarack, *Larix laricina*, occurs sparingly with the black spruces in damp situations near Tanana and at the head of the north fork of the Kuskokwim, and the trunks reach a maximum diameter of eight inches.

The black spruce forest is not as a rule very dense, and a person can usually pass easily between the trees. The ground is heavily covered, to a depth of from several inches to several feet, with sphagnum moss, which retains a large amount of moisture. Various shrubs grow in the available space between the trees, the principal species being the dwarf birch, *Betula glandulosa*, blueberries, *Vaccinnum*, dwarf willows, *Salix*, dwarf alders, *Alnus*, and Labrador tea, *Ledum*. A few tough grasses of the type found in the niggerheads also occur, nearly covered by the sphagnum.

Lakes which occur in an area of black spruces are commonly invaded at their edges by the sphagnum. About such lakes the vegetation is usually not different from that of the black spruce forest, and no fringe of shrubs or other plants is developed. Neither is there any evidence for the presence of a water-margin vertebrate society about such lakes.

Timber-line willow-alder habitat and association:

Lagopus lagopus albus. Willow ptarmigan. Resident.
Lagopus rupestris rupestris. Rock ptarmigan. Resident.
Asio flammeus. Short-eared owl. Summer (Osgood).
Zonotrichia gambeli. Gambel sparrow. Summer.
Junco hyemalis hyemalis. Slate-colored junco. Summer.
Wilsonia pusilla pusilla. Wilson warbler. Summer.
Penthestes hudsonicus hudsonicus. Hudsonian chickadee. Summer.
Acanthopneuste borealis kennicotti. Kennicott willow warbler. Summer.
Regulus calendula calendula. Ruby-crowned kinglet. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Ixoreus nævius meruloides. Northern varied thrush. Summer.
Sorex personatus arcticus. Arctic shrew.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Lepus americanus macfarlani. Macfarlane snowshoe hare.

Thickets of scrub willow or alder frequently occupy the moist ground at the head of a ravine or cove at timber-line or above, and any small stream flowing above timber-line is likely to be fringed by a thicket of these shrubs. Tongues of stunted willows and alders also extend up protected slopes and gullies for a long distance above timber-line. A fringe of alders was found on

Mount Sischu to occur just above a white spruce–paper birch forest where this reached timber-line on a steep slope.

This habitat is somewhat more exposed to the winds than the lowland willow-alder habitat, and the species of animals in the habitats surrounding it differ to some extent from those of the habitats surrounding the lowland habitat. Yet, with a few apparent exceptions, the species found in the willows and alders are the same above timber-line as in the bottoms of the valleys.

Blueberry–dwarf birch habitat and association:

Canachites canadensis osgoodi. Alaska spruce grouse. Resident.
Lagopus lagopus albus. Willow ptarmigan. Resident.
Lagopus rupestris rupestris. Rock ptarmigan. Resident.
Pediœcetes phasianellus phasianellus. Sharp-tailed grouse. Winter.
Asio flammeus. Short-eared owl. Summer (Osgood).
Surnia ulula caparoch. Hawk owl. Resident.
Acanthis linaria linaria. Redpoll. Winter.
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Ursus americanus americanus. Black bear. Summer.
Vulpes alascensis alascensis. Alaska red fox.
Martes americana actuosa. Alaska marten.
Mustela arctica arctica. Arctic weasel.
Evotomys dawsoni dawsoni. Dawson red-backed vole.

A thick growth of low shrubs is commonly found in the open parts of the valleys, but especially on the hills just above timber-line. These shrubs are the common ones found in the black spruce forests, here growing more closely together and forming more of a thicket. The dominant species are the blueberries, *Vaccinnum*, and dwarf birch, *Betula glandulosa.* Other common species are the dwarf willows, *Salix*, dwarf alders, *Alnus*, and Labrador tea, *Ledum.* Clumps of the niggerhead grass are often abundant, and occasional small, stunted black spruces occur. The ground is usually heavily covered by sphagnum, with which is frequently growing reindeer "moss," *Cladonia rangiferina.*

Bare-ridge habitat and association:

Lagopus lagopus albus. Willow ptarmigan. Resident.
Lagopus rupestris rupestris. Rock ptarmigan. Resident.
Surnia ulula caparoch. Hawk owl. Winter.
Otocoris alpestris arcticola. Pallid horned lark. Summer.
Leucosticte tephrocotis. Gray-crowned rosy finch. Summer (Blackwelder).
Calcarius lapponicus alascensis. Alaska longspur. Summer (Osgood).
Calcarius pictus. Painted longspur. Summer (Blackwelder).
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer (Blackwelder).
Anthus spinoletta rubescens. Pipit. Summer.
Saxicola œnanthe œnanthe. Wheatear. Summer (Blackwelder).
Ursus phœonyx. Tanana grizzly. Summer (Osgood).
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Microtus pennsylvanicus drummondi. Drummond vole.
Microtus operarius endœcus. Interior vole (Osgood).
Rangifer stonei. Stone caribou.
Ovis dalli. Dall sheep (Osgood).

On the ridges and slopes of the higher hills or mountains where the ground is not covered by rocks there is either a sparse growth of grass or of sphagnum moss. The grass is found in the more swampy situations, such as at the head of a cove, while the moss covers the drier slopes. On Mount Sischu at an estimated elevation of 2,500 feet the blueberries and other shrubs almost disappear, and the slopes above are carpeted with a thin covering of moss, through which small loose rocks often project. A few very low shrubs occur at intervals, and sometimes small patches of bare ground appear.

Rocky-slope habitat and association:

Lagopus rupestris rupestris. Rock ptarmigan. Resident.
Otocoris alpestris arcticola. Pallid horned lark. Summer.
Leucosticte tephrocotis. Gray-crowned rosy finch. Summer (Osgood).
Saxicola œnanthe œnanthe. Wheatear. Summer (Osgood).
Mustela arctica arctica. Arctic weasel (Osgood).
Marmota caligata caligata. Hoary marmot (Osgood).
Ochotona collaris. Collared pika (Osgood).
Ovis dalli. Dall sheep (Osgood).

A few talus slopes occur on the higher parts of the mountains of interior Alaska. Some of the slopes are of considerable extent, though most are small. Also many of the higher mountains are flat topped, and these tops are usually covered by large broken rocks. Lichens are abundant on the rocks which remain long in one position. However, the topography of interior Alaska north of the Alaska Range is not rugged, but is mostly of a rolling type in which rock exposures are few.

Aerial habitat and association:

Sayornis sayus. Say phoebe. Summer (Osgood).
Nuttallornis borealis. Olive-sided flycatcher. Summer.
Empidonax trailli alnorum. Alder flycatcher. Summer (Osgood).
Hirundo rustica erythrogaster. Barn swallow. Summer.
Petrochelidon lunifrons lunifrons. Cliff swallow. Summer.
Tachycineta thalassina lepida. Northern violet-green swallow. Summer (Osgood).
Riparia riparia riparia. Bank swallow. Summer.
Wilsonia pusilla pusilla. Wilson warbler. Summer.
Saxicola œnanthe œnanthe. Wheatear. Summer.

The aerial association in interior Alaska is made up of the flycatchers, swallows, Wilson warbler, and wheatear, all of which are birds securing food in the air.

Burn habitat and association:

Canachites canadensis osgoodi. Alaska spruce grouse. Resident.
Lagopus lagopus albus. Willow ptarmigan. Winter.
Buteo swainsoni. Swainson hawk. Summer.
Surnia ulula caparoch. Hawk owl. Resident.
Dryobates pubescens nelsoni. Northern downy woodpecker. Autumn.
Picoides americanus fasciatus. Alaska three-toed woodpecker. Resident.
Nuttallornis borealis. Olive-sided flycatcher.
Perisoreus canadensis fumifrons. Alaska jay. Resident.
Pinicola enucleator alascensis. Alaska pine grosbeak. Autumn.
Loxia leucoptera. White-winged crossbill. Winter.
Acanthis hornemanni exilipes. Hoary redpoll. Winter.
Acanthis linaria linaria. Redpoll. Resident.
Acanthis linaria holbœlli. Holboll redpoll. Winter.
Plectrophenax nivalis nivalis. Snow bunting. Winter.
Zonotrichia gambeli. Gambel sparrow. Summer, breeding.
Spizella monticola ochracea. Western tree sparrow. Summer.
Junco hyemalis hyemalis. Slate-colored junco. Summer, breeding.
Melospiza lincolni lincolni. Lincoln sparrow. Summer.
Bombycilla garrula pallidiceps. Bohemian waxwing. Summer.

Vermivora celata celata. Orange-crowned warbler. Summer.
Hylocichla aliciæ aliciæ. Gray-cheeked thrush. Summer.
Planesticus migratorius migratorius. Eastern robin. Summer.
Sorex tundrensis. Tundra shrew.
Mustela arcticus arcticus. Arctic weasel.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Microtus operarius endœcus. Interior vole.
Alces gigas. Alaska moose.

Extensive areas of forest in interior Alaska have been burned, for fires are common. Forests of both the black spruce type and of the white spruce–paper birch type are destroyed by these fires, and though the trees themselves are seldom burned they are killed by the fire at their bases. In a burned black spruce forest the dead trees may stand for many years, but the larger white spruces are more easily blown down by the wind, and seemingly are more apt to be partially burned.

Following a fire in a location suitable for the development of a white spruce–paper birch type of forest, the first year herbs seem to take control. Of these herbs the most characteristic is the fireweed, *Chamænerion angustifolium.* It is not known how long the herbaceous stage continues, but grasses invade the area, and then willows and alders; paper birch finally succeeds the alders; and under the birches white spruces develop.

Following a fire in a black spruce forest the sphagnum moss is very slow to return. No burned forest of this type was studied in the first year following a fire, but it is probable that there is a herbaceous or fireweed stage here also. The tussock grasses of the niggerhead type appear after a time, and then willows, alders, blueberries, dwarf birch, and sphagnum. Ultimately, after the lapse of many years, the black spruce forest will be re-established.

The burn habitat as here considered includes all the stages following a fire until the new forest begins to show its own individuality.

Cultivated-field habitat and association:

Anthus spinoletta rubescens. Pipit. Summer.

Cultivated fields are rare in interior Alaska, but they are increasing in number and size. The only vertebrate record at hand from this habitat is that of the pipit, of which a small flock was seen in a plowed field in the Yukon Valley at Tanana.

Edificarian habitat and association:

Sayornis sayus. Say phoebe. Summer (Osgood).
Perisoreus canadensis fumifrons. Alaska jay. Resident.
Corvus corax principalis. Northern raven. Winter.
Passerculus sandwichensis alaudinus. Western savanna sparrow. Summer (Osgood).
Zonotrichia gambeli. Gambel sparrow. Summer.
Passerella iliaca iliaca. Fox sparrow. Summer.
Petrochelidon lunifrons lunifrons. Cliff swallow. Summer, breeding.
Tachycineta thalassina lepida. Northern violet-green swallow. Summer, breeding (Osgood).
Planesticus migratorius migratorius. Eastern robin. Summer (Osgood).
Sorex personatus arcticus. Arctic shrew.
Sorex obscurus obscurus. Mountain shrew.
Microsorex eximius. Alaska microsorex.
Mustela arctica arctica. Arctic weasel.
Mustela vison ingens. Alaska mink.
Evotomys dawsoni dawsoni. Dawson red-backed vole.
Rattus norvegicus. Norway rat.
Sciurus hudsonicus hudsonicus. Northern red squirrel.

Several species of vertebrates are closely restricted to the vicinity of buildings, and a number of other species sometimes make use of buildings either as places of refuge or as places of food supply. To designate this habitat and association the name *edificarian* is proposed. The habitat includes the buildings of whatever sort erected by man, and the immediately adjacent areas. This would include the streets of cities and the yards of houses with their planted lawns, gardens, and shade trees. However, it does not seem desirable to include in the habitat parks, orchards, or cultivated fields away from the near vicinity of buildings.

Buildings and towns are rare in Alaska, so the habitat is extremely small in area. Nevertheless, at least one species of mammal, the Norway rat, is restricted to it, and a number of species of other mammals and birds either nest or feed in or around buildings.

PLATE I

Fig. 1.—A small lake near the junction of the east fork with the north fork of the Kuskokwim. A belt of horsetails, *Equisetum*, surrounds the edge of the lake; outside this in the foreground is a belt of sedges, while the forest of white spruce and paper birch appears on the right. July 9, 1912.

Fig. 2.—Niggerheads in the Yukon Valley near Tanana. These are tussocks of tough grasses which grow higher from year to year, often reaching a height of two to three feet above the general level of the ground. September 12, 1911.

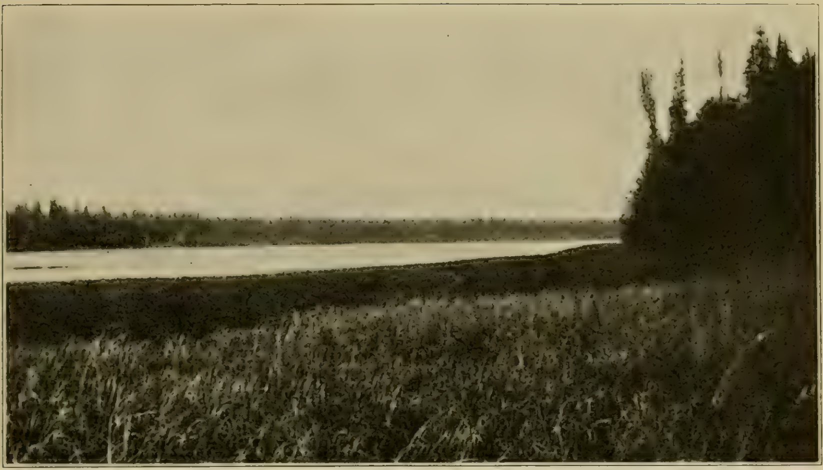

Figure 1

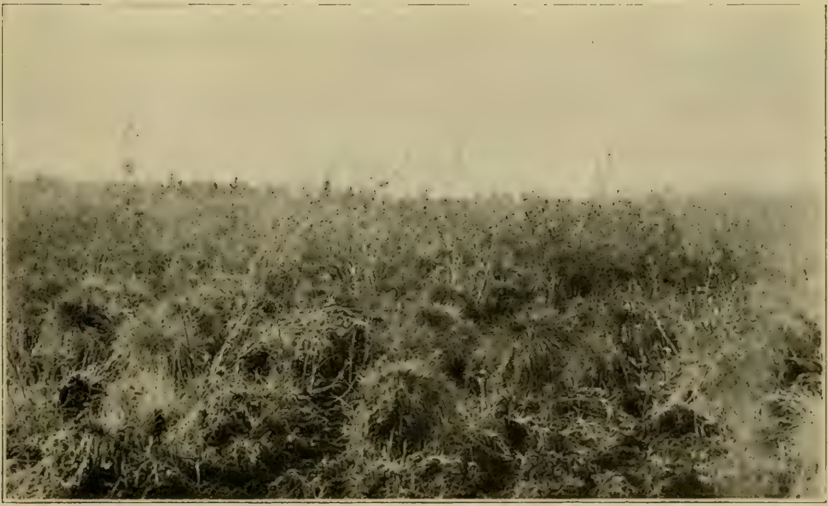

Figure 2

PLATE II

FIG. 1.—The north fork of the Kuskokwim near its head. A gravel bar shows on the left, fringing which is a thicket of willows and alders. On the right in the foreground and in the left in the distance the river has formed a cut bank. The forest is of white spruces and paper birches. April, 1912.

FIG. 2.—The ridges north of Takotna at timber-line. Stunted black spruces are almost the only trees, and these grow best in the slightly protected draws. Along the tiny streams in the ravines are small thickets of willow and alder. Dwarf birches and blueberries grow thickly in the open places among the spruces and for a short distance above timber-line July, 1912.

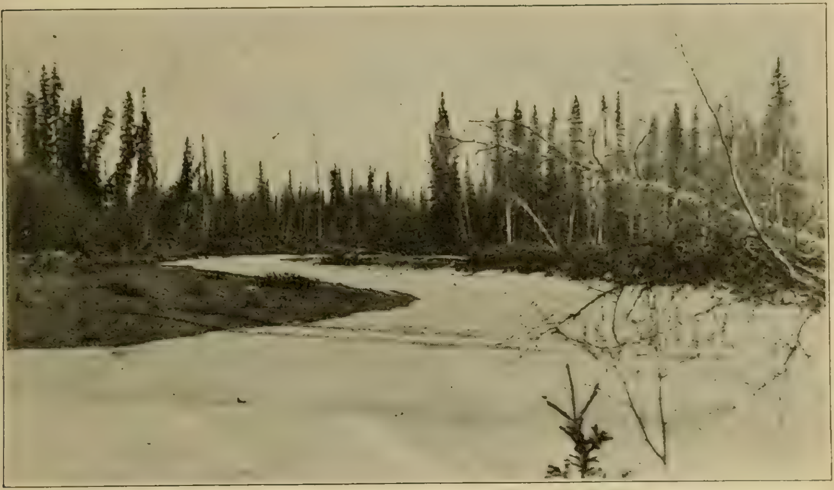

Figure 1

Figure 2

PLATE III

FIG. 1.—A white spruce-paper birch forest beside the Koyukuk trail on the low hills north of Tanana. The birches have already lost most of their leaves. September 12, 1911.

FIG. 2.—Stunted black spruces at the head of the north fork of the Kuskokwim. None of the trees in the picture are over three inches in diameter. April 28, 1911.

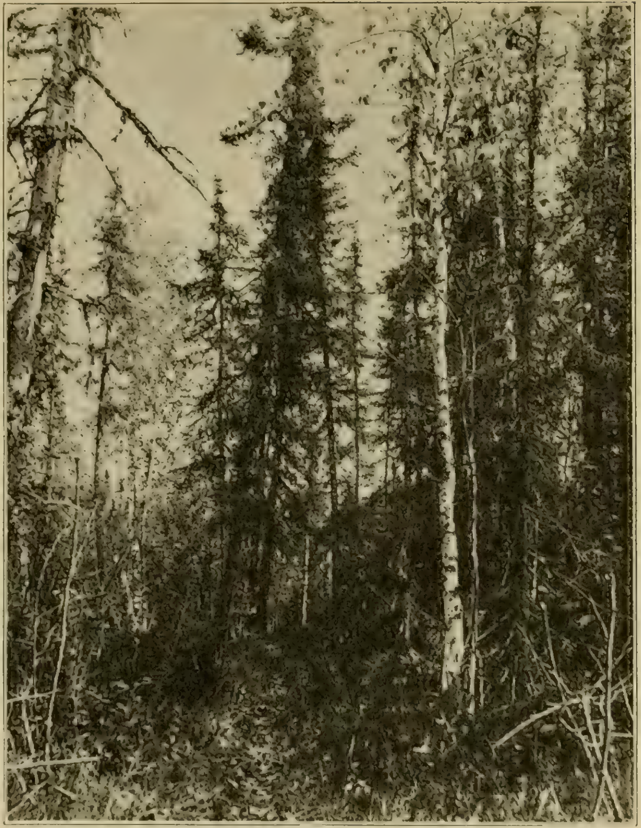

Figure 1

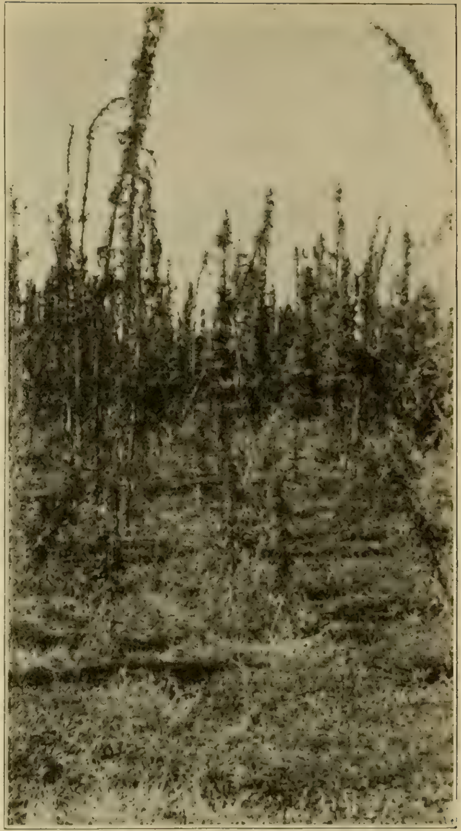

Figure 2

PLATE IV

Fig. 1.—The upper slopes of Mount Sischu, forming the divide between Novi and Kuskokwim rivers. Scanty exposures of lichen-covered rocks appear, and the ground is sparsely covered by sphagnum and grass. The flat top of the summit in the distance shows plainly. June 5, 1912.

Fig. 2.—Burned black spruce forest near the head of the north fork of the Kuskokwim. The shrubs are mostly dwarf birch. April 28, 1912.

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THE MAMMALS OF WARREN WOODS, BERRIEN COUNTY, MICHIGAN

BY LEE RAYMOND DICE

Few detailed studies of the mammal associations of the forests of the United States have been made. But if we are ever to know, for our different species of mammals, the natural environments under which their evolution and differentiation occurred, we must study and describe their habitats and habitat limitations before all the native areas in the country have been altered by the activities of mankind. As a contribution to this subject the following paper is presented.

The Warren Woods are a state preserve under the Edward K. Warren Foundation. They are located in Berrien County, Michigan, about three miles north of Three Oaks. The preserve consists of about two hundred acres, of which somewhat less than half is in clearing and the remainder mostly covered by forest, much of it still nearly in its primitive condition.

The topography is nearly level, though the area is cut by a number of ravines draining to the Galien River, which flows

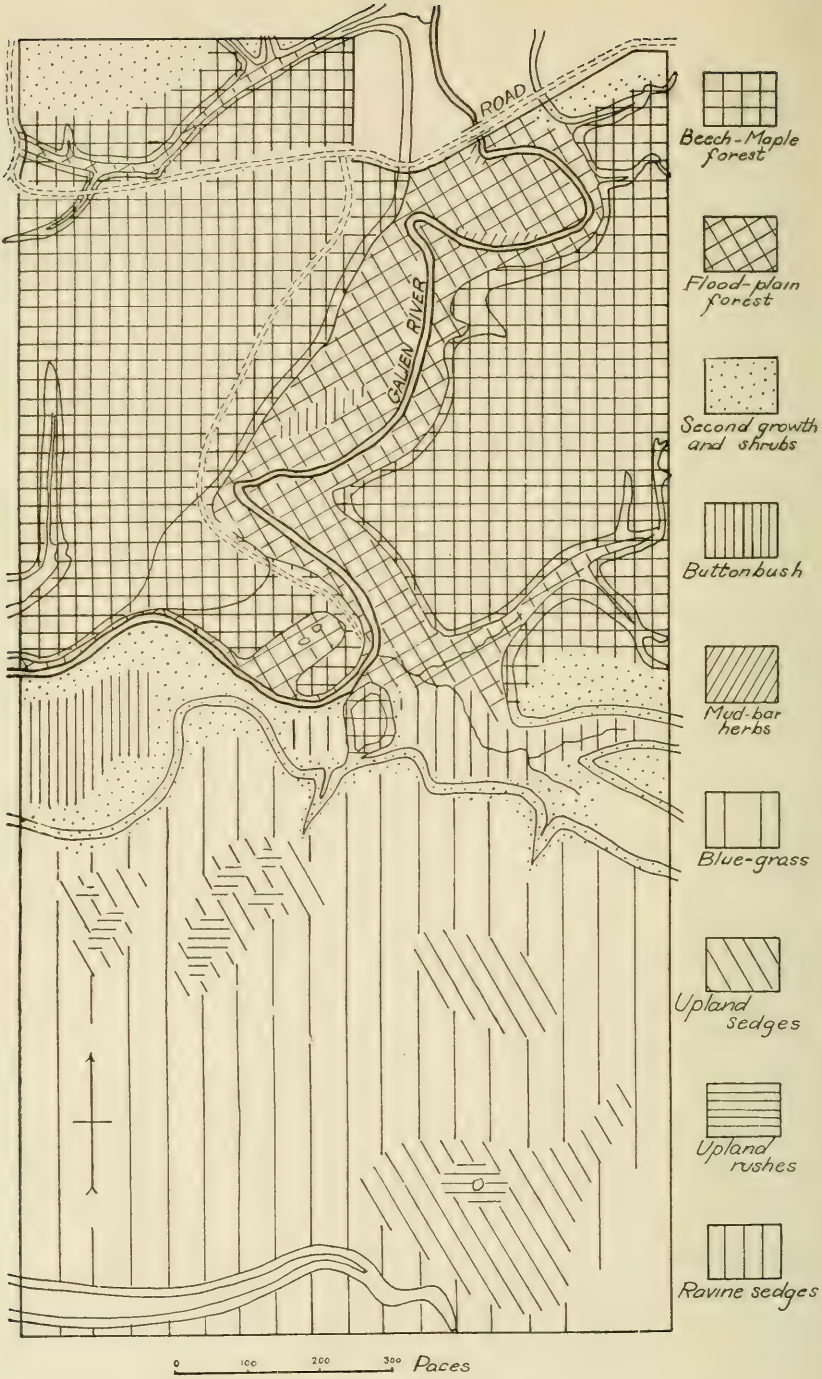

FIG. 1.—Sketch map of Warren Woods Preserve. The distribution of the various mammal habitats is indicated.

through the preserve. Along the river and in its bends there are moderate-sized flood-plains.

On the flood-plains a few small buttonbush swamps occur; and along the margins of the river a few freshly formed mud bars have not yet become forested; but most of the flood-plains are covered by heavy forest. The higher ground, except that in the clearing, is covered by heavy beech-maple forest.

Several types of habitats are represented in the clearing: in a few of the cleared ravines a thick growth of sedges and iris occurs; on the higher ground small areas are dominated by rushes, other areas by sedges, while the greater part is covered by grass. In parts of the clearing blackberries and other shrubs have grown up to form thickets, and in many places, especially along the edges of ravines, second-growth trees of oak, maple, or beech grow in the thickets or form small groves.

The mammal habitats found on the preserve may be listed as follows:

Natural habitats

Aquatic habitat
Buttonbush-swamp habitat
Shore habitat
Mud-bar herbage habitat
Flood-plain forest habitat
Beech-maple forest habitat
Aerial habitat

Modified and artificial habitats

Second-growth forest and scrub habitat
Cleared-ravine sedge habitat
Cleared-upland rush habitat
Cleared-upland sedge habitat
Cleared-upland blue-grass habitat
Cultivated field habitat
Orchard habitat
Edificarian habitat

It is unfortunate that all of the area in clearing and about half of the forested area on the preserve has been and is being heavily pastured by cattle and horses. The presence of stock has changed the native conditions so much that, so far as interpreting the primitive mammal associations is concerned, little dependence can be placed on studies made in that portion of the preserve. The grass and herbage is extensively eaten off, and many of the shrubs and young trees eaten or badly mutilated. Under the pastured forest little underbrush or herbage remains, and the conditions are very poor for small mammals.

In all the forest, in the unpastured as well as in the pastured part, a number of trees have been cut out in former years, and although no trees are now being cut down, all the trees and branches which fall are being cut up for firewood. This results in there being few logs and little dead brush on the ground, and removes a favorite place for small mammal nests and runways, as well as largely eliminating as mammal food the insects and larvae which are dependent on decaying wood. However, with the exception of the removal of the logs and of a few trees, that part of the forest to the north of the river is still in practically its native condition, and it shows no evidence of ever having been pastured. It is thus a splendid place for the study of the native faunal conditions.

Although the whole area in the preserve is small there are other areas of adjoining forest along the Galien River, so that, for the smaller mammals at least, the results of the study and trapping should indicate the primitive habitat distribution. The relative abundance of the different species, however, is probably much changed by the decrease throughout the whole region of the carnivores, which have been much hunted and trapped by man.

The mammals of Warren Woods were intensively studied by the author from July 3 to September 3 in the summer of 1919. A camp was maintained near the edge of the Woods, and by trapping and hunting every effort was made to determine the mammal fauna of the preserve. From one hundred to two hundred traps for small mammals and about twenty traps for the larger species were kept constantly in operation. A small amount of trapping was done in the fields and along the roadsides immediately adjoining the Woods and a few records were secured from the camp house.

The work was supported by the Michigan Geological and Biological Survey. Dr. Alexander G. Ruthven directed the work and gave much assistance in securing the needed collecting equipment. Much help was given by George R. Fox, Director of the Warren Foundation, not only in getting to and from the camp at the Woods and in numerous other courtesies, but also in information about the Woods and about the mammals there. The plant identifications were made by Mr. C. Billington.

The figures following the specific names in the lists of mammals from each habitat indicate the number of individuals trapped, shot, or seen and positively identified in that habitat.

NATURAL HABITATS

Aquatic habitat:

Mustela vison mink. Mink. Reported.
Fiber zibethicus zibethicus. Muskrat. Reported.

Mink and muskrat are reported by residents to occur in the Galien River in and near Warren Woods, but I was unable to secure any specimens though traps were set for them; neither did I see any signs of their presence.

Buttonbush-swamp habitat:

Peromyscus leucopus noveboracensis. Northern white-footed mouse. 8.
Mus musculus musculus. House mouse. 2.

A large buttonbush swamp occurs in the preserve just south of the Galien River, but around this the native trees have been cut away and over its accessible edges it has been heavily pastured, so that it is not at all in its natural conditions, and it was not trapped. In the unpastured flood-plain north of the river there is another buttonbush swamp of several hundred yards extent. This latter area was the one selected for study.

In this typical swamp the buttonbush, *Cephalanthus occidentalis*, is practically the only plant present. It thickly covers the area with its tangled branches, which grow to heights of four to ten feet. The water had drained away in August, leaving the ground bare, though still wet and soft. Under the cover of the buttonbush there is no herbage whatever, and upon the ground there are only a few decaying logs and a few small sticks, which often carry a light growth of moss.

Around the edges of this swamp there is a narrow belt of thick herbage, closely encroached upon by the typical forest of the flood-plain.

Fifty mouse traps set in this habitat took eight northern white-footed mice and two house mice the first night, August 5.

Shore habitat:

Procyon lotor lotor. Raccoon. Tracks.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 1.

Along the shores of the Galien River a narrow strip of bare ground was exposed in July and August. The ground of this strip is mostly mud, but in a few places it is sand or gravel. Usually the habitat is narrow, but in some places it is five to ten feet wide.

Tracks of raccoon were frequent on the shore along the river. From a few mouse traps set on the bare mud shore one northern white-footed mouse was taken August 4 beside a drift log.

Mud-bar herbage habitat:

Peromyscus leucopus noveboracensis. Northern white-footed mouse. 4.

A few small recently formed mud bars occur along the Galien River in its outer bends. These bars have not yet had time to become forested, and on their outer edges nearest the river there is usually no vegetation, this part being included in the shore habitat. On their older portions next the forest of the flood-plains occurs a thick growth of herbs, several annual grasses, and rarely a willow, *Salix* sp., or a seedling tree of white elm, *Ulmus americana*, cottonwood, *Populus deltoides*, maple, *Acer rubrum* or *saccharinum*, and others of the typical flood-plain species. The vegetation during August is very thick, and reaches a height of four to six feet. The soil is either mud or in a few places fine sand, and the ground is quite moist.

In this habitat four northern white-footed mice were trapped August 3–4.

Flood-plain forest habitat:

Scalopus aquaticus machrinus. Prairie mole. Ridges.
Blarina brevicauda talpoides. Short-tailed shrew. 4.
Procyon lotor lotor. Raccoon. 1.
Mustela noveboracensis noveboracensis. New York weasel. 1.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 52.
Microtus pinetorum scalopsoides. Northern pine vole. 5.
Mus musculus musculus. House mouse. 2.
Zapus hudsonius hudsonius. Hudson Bay jumping mouse. 1.
Erethizon dorsatum dorsatum. Canada porcupine. Tooth marks.
Marmota monax monax. Southern woodchuck. 4.
Sciurus hudsonicus loquax. Southern red squirrel. 4.
Sylvilagus floridanus mearnsii. Mearns cottontail. 1.

There are considerable areas of flood-plain along the Galien River, and except for the recently formed mud bars the flood-plains are heavily covered with a mixed forest in which the linden, *Tilia americana*, white elm, *Ulmus americana*, and sycamore, *Platanus occidentalis*, are conspicuous species. Under this forest there are a few small trees, but there is very little underbrush. The herbage also is sparse and, though in a few places there is a considerable growth of ferns, grasses, and sedges, and of other herbs, there are also many bare areas.

One of the significant features of the flood-plains, so far as the mammals are concerned, is the flooding to which these areas are subjected during the spring high-water. At that time the flood-plain for a number of days or weeks may be covered with several feet of water.

During the period between July 29 and August 28 a total of one hundred and seventy mouse traps set in the flood-plain forests along the Galien River took for the first nights' trapping, twenty-two northern white-footed mice and one house mouse. Short-tailed shrews, more white-footed mice, pine voles, and a jumping mouse were secured on nights after the first. Larger traps took during the whole period one raccoon, one New York weasel, and two woodchucks. Several other woodchucks and a number of red squirrels were seen. Ridges of moles were numerous, but no specimens were secured. Tooth marks on an old, partly fallen linden were probably made, perhaps a number of years ago, by a porcupine.

Throughout the woods there are a number of small ravines. These ravines are forested with trees mostly of the flood-plain type, and there is evidence in many of the ravines, at least in their lower parts, that flooding occurs in the ravine bottom during the spring.

Fifty mouse traps set August 26 in a large ravine north of the county road took on the first day five northern white-footed mice and one house mouse. Short-tailed shrews, more white-footed mice, and pine voles were trapped on following days. Here also red squirrels and a cottontail were seen, and tracks of raccoon noted. Evidently the fauna is the same as that of the flood-plain, with which it is here included.

Beech-maple forest habitat:

Blarina brevicauda talpoides. Short-tailed shrew. 7.
Procyon lotor lotor. Raccoon. Tracks.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 86.
Microtus pinetorum scalopsoides. Northern pine vole. 5.
Zapus hudsonius hudsonius. Hudson Bay jumping mouse. 1.
Marmota monax monax. Southern woodchuck. Burrows.
Tamias striatus lysteri. Northeastern chipmunk. 1.
Sciurus hudsonicus loquax. Southern red squirrel. 10.
Sciurus niger rufiventer. Fox squirrel. 7.
Sylvilagus floridanus mearnsii. Mearns cottontail. 1.

The climax forest of the region is dominated by the beech, *Fagus grandiflora*, and the sugar maple, *Acer saccharum*. The trees in this forest are very large, so that the forest crown is high and the shade dense. Only a few small trees occur and these are mostly young beeches and young sugar maples. The underbrush varies much in height and denseness; mostly it is quite open, so that one can easily walk through the forest, but in a few places the growth is more dense. Common members of the underbrush on the higher ground are the small beeches, sugar maples, and the spice-bush, *Benzoin aestivale;* while on the lower benches along the river seedlings of the paw-paw dominate the undergrowth. The ground is heavily covered by decaying leaves and a little dead brush and fallen branches, but nearly all the logs have been removed. Early in the spring a thick growth of herbs covers the ground, but by July the herbs are mostly gone, only a few remaining, and there are many small bare areas covered only by leaves. The soil under this forest seems to be mainly clay; in spring or after heavy rains pools of water are formed, and these remain for a long time.

Between July 21 and August 27 a total of two hundred and eighty-five mouse traps set in the upland forest took on the first nights one short-tailed shrew and thirty northern white-footed mice. In addition to these species pine voles and a jumping mouse were trapped on days after the first. One shrew was caught alive August 30, as he was running about on the forest floor at 7:30 A.M. A few tracks of raccoon were seen from time to time on the road leading through the woods. A few fresh burrows of woodchucks were noted at the edges of benches and of ravines. A few red squirrels were seen at different times and two collected. Fox squirrels were rare, being noted only a few times; Mr. Norman A. Wood also saw these squirrels on two occasions in May. One cottontail was shot, in the climax forest. Mr. Wood collected a chipmunk in the climax forest on May 15, 1918, and saw another in the same habitat in May, 1919.

Aerial habitat:

Bats were seen on a few evenings, flying about over the climax forest, and over the adjacent region, but they were extremely rare, and efforts to shoot a specimen failed.

MODIFIED AND ARTIFICIAL HABITATS

Second-growth forest and scrub habitat:

Mustela noveboracensis noveboracensis. New York weasel. 1.
Mephitis nigra. Eastern skunk. 1.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 5.
Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole. 4.
Mus musculus musculus. House mouse. 1.
Marmota monax monax. Southern woodchuck. 1.
Sciurus hudsonicus loquax. Southern red squirrel. 1.
Sylvilagus floridanus mearnsii. Mearns cottontail. 5.

Small trees and brush have grown up along the edges of many of the ravines in the cleared fields in and surrounding the preserve. Many of the trees are oaks, but beech and hard maple also occur, a few of them being relics from the original forest. Considerable brush is present, formed by a large variety of species. A few other small patches, especially in ravine bottoms and on flood-plains have been allowed to grow up to brush and small trees. In nearly every case these areas are heavily pastured.

The conditions here included in the second-growth forest and scrub habitat are not homogeneous, but differ in each different location where the habitat is found, tree and shrub species abundant in one situation not being present in another. The habitat is usually narrow in extent, being often confined to the width of the steep ravine wall.

Owing to its poor development and uncertain characteristics no intensive trapping was done in this type of habitat. A weasel was trapped in open beech-maple-oak forest at the edge of a cleared ravine, and a woodchuck was shot in the same type of habitat. Another woodchuck and a skunk were trapped at different times in low willow brush on the banks of the river just north of the woods. Northern white-footed mice, Pennsylvania voles, and a house mouse were trapped in thick oak brush and trees alongside a road north of the woods. A red squirrel was shot in second-growth oak and aspen woods in the north part of the preserve, and they were seen in open woods along ravines.

Cottontails were noted a few times in blackberry thickets, in brush in ravines, in clearings along the river, and in beech-maple-oak forest along ravines.

Cleared-ravine sedge habitat:

Blarina brevicauda talpoides. Short-tailed shrew. 1.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 3.
Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole. 5.

A large ravine south of the river had been cleared of trees evidently several years previously, and it has now grown up mostly to sedges, grass, and iris in its more moist parts. Along the little brook which flows through the ravine there is a fringe of willows, and among the sedges a number of shrubs and small trees occur, mostly thorns and a few young sycamores and black walnuts.

Fifty mouse traps set in this habitat took on the first day, August 16, three northern white-footed mice and three Pennsylvania voles. More voles and a short-tailed shrew were taken on later days.

Cleared-upland rush habitat:

Mephitis nigra. Eastern skunk. Den.
Peromyscus maniculatus bairdii. Prairie white-footed mouse. 1.
Synaptomys cooperi. Cooper lemming-vole. 1.
Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole. 7.
Microtus ochrogaster. Prairie vole. 1.
Citellus tridecemlineatus tridecemlineatus. Thirteen-striped ground squirrel. 2.

In the shallow, poorly drained depressions of the cleared upland the vegetation is dominated by rushes, which grow in clumps and form a thick growth, reaching a height of about one meter as a maximum. At the edges of the habitat and in places not thickly covered by the rushes a growth of sedges, grasses, and moss covers the ground; but under the thickest growth of rushes the ground is bare and is evidently covered by water during a part of the year. On this upland one small pond surrounded by rushes did not dry up until late in August. In a few places small blackberry thickets occur in the areas of rushes and dominate all other plants.

Fifty traps set in this habitat, on August 8, took on the first night one prairie white-footed mouse and one Pennsylvania vole; the prairie white-footed mouse was taken just at the edge of the growth of rushes. Other Pennsylvania voles as well as a lemming-vole, a prairie vole, and several young ground squirrels were secured on later nights by the same trap-line. A skunk den was situated in a blackberry thicket in the midst of the largest patch of rushes.

Cleared-upland sedge habitat:

Peromyscus maniculatus bairdii. Prairie white-footed mouse. 3.
Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole. 1.
Microtus ochrogaster. Prairie vole. 9.
Mus musculus musculus. House mouse. 1.
Citellus tridecemlineatus tridecemlineatus. Thirteen-striped ground squirrel. Burrows.

Sedges are dominant over a part of the cleared upland, occurring on the moist gentle slopes which are too well drained for rushes, but not in any numbers on the drier and higher parts of the upland. With the sedges there are a few grasses, and the ground is sometimes covered by a moss, but the sedges are by far the most abundant plant.

Fifty mouse traps set in this habitat took on the first night, August 15, one prairie white-footed mouse and one prairie vole. Other prairie voles and white-footed mice were taken on later nights, as well as one Pennsylvania vole and one house mouse. Burrows of the thirteen-striped ground squirrel were numerous in the sedges.

Cleared-upland blue-grass habitat:

Peromyscus maniculatus bairdii. Prairie white-footed mouse. 12.
Mus musculus musculus. House mouse. 1.
Citellus tridecemlineatus tridecemlineatus. Thirteen-striped ground squirrel. 23.

The most widespread habitat of the cleared upland on the south part of the preserve is the blue-grass habitat. In this habitat the blue-grass, *Poa*, is the dominant plant, growing to a height of usually not over 0.5 meter. With the blue-grass are associated a few thistles, yarrow, and several other herbs. During the whole period of my stay in the region, July and August, the habitat was very dry, and the grass and herbs had mostly dried up. This habitat and all the other habitats of the clearing were being heavily pastured by stock.

Trap-lines totaling one hundred mouse traps, set on August 6 and August 18, took on the first nights two prairie white-footed mice, one house mouse, and one young thirteen-striped ground squirrel. More white-footed mice were taken on later nights. Many ground squirrels were taken in larger traps at the mouths of their burrows; most of these were young of the year, and all of them were very fat in preparation for their approaching hibernation.

Cultivated field habitat:

Scalopus aquaticus machrinus. Prairie mole. 1.
Peromyscus maniculatus bairdii. Prairie white-footed mouse. 23.
Microtus ochrogaster. Prairie vole. 1.
Mus musculus musculus. House mouse. 2.
Sylvilagus floridanus mearnsii. Mearns cottontail. 2.

Cultivated fields occur throughout the region about the woods, but the only ones in which trapping was done were wheat stubble-fields. After the wheat was cut off these stubble-fields grew up rather thickly to weeds. On the ground there were a number of fallen heads of wheat and some shelled-out grain, furnishing abundant food for mice.

Seventy mouse traps set in a wheat stubble-field just north of Warren Woods, caught on the first nights, August 13 and August 29, sixteen prairie white-footed mice. Other white-footed mice and two house mice were taken on later nights. Several cottontails were seen in this field, and a few mole ridges were noted. A prairie mole was taken by Clifford Reid in a grassy patch at the edge of a garden. In another wheat field the Helming boys picked up a prairie vole.

Orchard habitat:

Peromyscus leucopus noveboracensis. Northern white-footed mouse. 1.
Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole. 2.

No especial study of the mammal life of the orchard was made, and no intensive trapping was done in the habitat. However, the orchard cannot be included in any of the other habitats recognized in the region.

A northern white-footed mouse was caught alive by the Helming boys in an orchard on July 16. A vole was seen to cross a road in a small orchard on July 15; a trap was set and two Pennsylvania voles secured, one a young of the year.

Edificarian habitat:[1]

Blarina brevicauda talpoides. Short-tailed shrew. 1.
Peromyscus leucopus noveboracensis. Northern white-footed mouse. 2.
Rattus norvegicus. Norway rat. 4.
Mus musculus musculus. House mouse. 22.
Sylvilagus floridanus mearnsii. Mearns cottontail. 2.

From time to time a few traps were set in the old farmhouse and in the barn and other outbuildings of our camp. In these buildings northern white-footed mice, Norway rats, and house mice were taken. Several cottontails were seen in and under the old barn. The Helming boys trapped a short-tailed shrew and also house mice and a white-footed mouse in the basement of their house.

RECORDS OF THE NUMBER OF EMBRYOS

All the females taken were examined for embryos, and the results are here tabulated by species and dates. The term *subadult* is used to indicate an individual which has reached adult size, but which is still immature as shown by the pelage, unworn condition of the teeth, and weakness of the skull sutures. For each individual the age is first stated, next the number of embryos if any, and last the length of the embryos in millimeters measured as they lie rolled in the fetal membranes. For embryos too small to measure with field equipment the term *small* is applied.

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[1] L. R. Dice, *Occasional Papers, Mus. Zool.*, No. 65.

These records indicate the breeding period of the different species and the number of young.

Mephitis nigra. Eastern skunk

August 19: subadult, 0 embryos.

Peromyscus leucopus noveboracensis. Northern white-footed mouse

July 16: adult, 3 embryos, size small.
July 21: adult, 0; adult, 0.
July 22: adult, 5, 10.5 mm.; subadult, 0.
July 23: subadult, 0.
July 25: juvenile, 0; juvenile, 0; juvenile 0; subadult, 3, small.
July 30: adult, 0; adult, 0; adult, 0; subadult, 0.
August 2: adult, 0; subadult, 2, small; subadult, 0; subadult, 0.
August 5: adult, 5, small; subadult, 0.
August 23: subadult, 0; adult, 5, 10 mm.
August 24: adult, 5, 8 mm.; adult, 0; adult, 0; adult, 3, small.
August 25: adult, 5, 23 mm.; adult, 0; adult, 4, small; adult, 3, small.
August 26: subadult, 4, 8 mm.; adult, 0.
August 29: adult, 4, 17 mm.

Peromyscus maniculatus bairdii. Prairie white-footed mouse

August 7: subadult,0.
August 10: adult, 5, 8 mm.
August 13: adult, 3, 8 mm.; adult, 0.
August 20: adult, 5, small.
August 28: adult, 4, 17 mm.; adult, 4, 13 mm.
August 29: adult, 5, 17 mm.
August 30: adult, 0; adult, 4, 11 mm.

Synaptomys cooperi. Cooper lemming-vole

August 11: adult, 2, 10 mm.

Microtus pennsylvanicus pennsylvanicus. Pennsylvania vole

July 15: adult, 4, not measured; juvenile, 0.
August 9: subadult, 0.
August 10: subadult, 0; subadult, 0.

August 13: subadult, 0.
August 16: adult, 0.
August 24: adult, 4, 11 mm.

Microtus ochrogaster. Prairie vole

July 25: juvenile, 0.
August 15: adult, 4, small.

Microtus pinctorum scalopsoides.
Northern pine vole

July 22: juvenile, 0.
July 25: juvenile, 0.
July 31: adult, 0.

Rattus norvegicus. Norway rat

July 11: adult, 7, 37 mm.
July 12: adult, 9, 26 mm.
July 14: juvenile, 0.

Mus musculus musculus. House mouse

July 9: subadult, 0.
July 10: juvenile, 0; subadult, 0.
July 11: adult, 0 (was nursing 3 or more half-grown young).
July 17: adult, 11, 6 mm.
July 22: adult, 7, 3.5 mm.

Zapus hudsonius hudsonius. Hudson Bay jumping mouse

July 27: subadult, 0.

Marmota monax monax. Southern woodchuck

July 11: adult, 0.
July 28: juvenile, 0.
August 3: adult, 0.
August 22: juvenile, 0.

Citellus tridecemlineatus tridecemlineatus. Thirteen-striped ground squirrel

August 14: adult, 0.

Sciurus hudsonicus loquax. Southern red squirrel

July 24: adult, 0.
July 27: juvenile, 0.

Sciurus niger rufiventer. Fox squirrel

August 11: subadult, 0.

Sylvilagus floridanus mearnsii. Mearns cottontail

July 21: adult, 4, 70 mm.

NEW STATE RECORD OF THE PRAIRIE VOLE

The specimens of prairie vole, *Microtus ochrogaster*, listed above from the sedges and rushes of cleared upland in the Warren Woods preserve and from a nearby wheat field constitute the first authentic record of the species from Michigan. The prairie vole had previously been erroneously reported to be abundant in Washtenaw County by Covert[2], who evidently mistook the Pennsylvania vole for this species.

OTHER MAMMALS OF THIS REGION

The following notes on mammals formerly or at present living in the region but not found by me in Warren Woods are based mostly on information furnished by George R. Fox, Director of the Edward K. Warren Foundation, and by William Schmidt, a trapper and hunter.

Didelphis virginiana virginiana. Virginia opossum. Three were seen and one captured in Three Oaks in the winter of 1919–20, and another was found in a granary on the outskirts of the town. The previous winter one was shot just southwest of town, and another was seen in a ravine north of Harbert. One was killed in Warren Woods some time ago.

Condylura cristata. Star-nosed mole. Mr. Hans captured one four miles south of Three Oaks, near the Indiana line in 1919, and brought the skin to Mr. Fox. One was taken by Dr. Parker at Lakeside in June, 1919.

Ursus americanus americanus. Eastern black bear. Formerly occurred in the region.

Canis lycaon. Timber wolf. About eleven years ago three were killed from a pack of nine wolves at Lakeside. About 1910 a pack of eight were seen at various times during the winter on the marsh between Three Oaks and Galien. The following winter the same pack, or another of the same number, was seen southwest of Three Oaks, and four of the pack were killed just over the Indiana line.

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[2] Adolphe B. Covert, *Natural History—History of Washtenaw County*, p. 194. 1881.

Vulpes fulva. Eastern red fox. Common in the region. One was killed in December, 1919, after having been chased from the Warren Woods by dogs. Another was seen in January, 1920, half a mile north of Three Oaks. In preceding winters a number have been killed south of Sawyer where they evidently come from the sand dunes.

Lutra canadensis canadensis. Canada otter. Formerly occurred along the streams, but are now apparently all gone.

Felis couguar. Cougar. One was killed a few miles northeast of Three Oaks many years ago. Another was killed near New Buffalo in the early days.

Lynx ruffus ruffus. Bobcat. One was killed a few years ago near the Galien River a few miles northeast of Three Oaks.

Erethizon dorsatum dorsatum. Canada porcupine. Found here in the early days.

Sciurus carolinensis leucotis. Northeastern gray squirrel. Black squirrels were found in numbers in the early days.

Glaucomys volans volans. Eastern flying squirrel. Said to be common. A large number were seen by Mr. Schmidt on one old stub in Warren Woods some years ago. Several were seen in 1918 by Mr. Fox in second-growth oak woods in a little ravine about one and one-fourth mile west of Warren Woods. One was caught in Three Oaks in the fall of 1919.

Cervus canadensis canadensis. American elk. One horn from a large swamp in Berrien County is in the Chamberlain Memorial Museum of Three Oaks.

Odocoileus virginianus borealis. Northern white-tailed deer. Formerly abundant in the region. Several molars were picked up in Warren Woods.

FOSSIL MAMMALS OF BERRIEN COUNTY

The records of fossil mammals from Berrien County here published have been collected by George R. Fox, who has also kindly loaned from the collections under his care several specimens for identification. Dr. E. C. Case assisted with the identification of the mammoth teeth.

Mammut americanum. Mastodon. (1) About 1897 the teeth of a mastodon were dug up by a dredge within the village limits of Eau Claire. Their disposition is unknown.

(2) At Snow, in section 36, Lake Township, a tooth was found. This came into the possession of Frank Striker of Buchanan.

(3) A portion of a tusk and part of a skull were found on the Beebe Farm near Baroda. These were sent to Washington, D.C.

(4) In the excavation of a ditch through a small marsh lying near Bakerstown in Section 3, of Bertrand Township, the dredge uncovered in the distance of between two and three miles bones, teeth, and other evidences of six mastodons. Of these remains the most important was a nearly complete skull with teeth in place and disintegrated parts of the tusks. The skull was secured by Dr. E. H. Crane, who restored parts; the tusks he did not attempt to restore. This skull is now on exhibition at the Ward Museum, Rochester, New York.

The skull lay about seven feet deep. It was under a bed of matted oak brush on top of which lay a huge stone slab, estimated to weigh two or three tons. Above was a layer of silt, then gravelly clay; above were more silt beds, three in number. W. Hillis Smith, who helped Dr. Crane secure the skull, furnished the above information.

(5) On the Avery marsh, two miles east of Three Oaks, a badly decayed mastodon skull and several teeth were excavated in 1884. Dr. Bonine, Sr., of Niles, assisted at the excavation. The bones and teeth were in the muck about twenty inches below the surface. Other teeth, making seven in all, were found near

the same place. Some of the teeth from this locality are on exhibition at the Chamberlain Memorial Museum of Three Oaks.

In addition to the above there are several indefinite records of mastodon remains from the county.

Elephas columbi. Columbian mammoth. (1) One-half of the tooth of a mammoth was found in the spring of 1917 on the Beeson and Holden farm in Section 6, NE. $\frac{1}{4}$, Township of Galien, by D. H. Beeson while cultivating corn. Two weeks later the other half of the tooth was found. The specimen is now in the Chamberlain Memorial Museum of Three Oaks.

The specimen is a well-worn lower third molar having twenty ridge-plates, but some of the ridge-plates have been worn out and lost. Seven and a half ridge-plates are included in a 100 mm. line. The greatest length of the tooth is 280 mm. and its greatest breadth 95 mm.

(2) A complete set of mammoth teeth with some portions of the bones was found about the year 1900 on a farm two miles southeast of Three Oaks owned by E. K. Warren. They were discovered while digging post holes. The specimens are on exhibition in the Chamberlain Memorial Museum.

One of the teeth sent us for identification proves to be a partly worn lower third molar having twenty-four ridge-plates. There are seven and a half ridge-plates in 100 mm. The greatest length of the tooth is 350 mm. and its greatest breadth 95 mm.

(3) There is another record of a mammoth tooth which was found at an unknown location in Berrien County. It was at one time owned by Mr. Smith, who gave it to Dr. Crane. Its present whereabouts is unknown.

PLATE I

A mud bar beside the Galien River in Warren Woods. A growth of mud-bar herbs adjoins the flood-plain forest on the left. August 29, 1919.

Flood-plain forest in Warren Woods. There are few shrubs; but a considerable amount of herbage is present. August 29, 1919.

PLATE II

Buttonbush swamp in Warren Woods. The swamp is surrounded by flood-plain forest. August 29, 1919.

Climax beech-maple forest on the higher ground in Warren Woods. August 29, 1919.

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A SYNOPSIS OF THE KING SNAKES: GENUS LAMPROPELTIS FITZINGER[1]

BY FRANK N. BLANCHARD

Owing to the probability of delay in publication of a complete monograph of the king snakes, which the writer now has in press, it has been deemed advisable to issue in advance this brief synopsis of the genus, in order to make immediately available the systematic results of the work.

In the following key the various forms have been arranged in general according to their affinities, but only in so far as such arrangement coincides with simplicity and convenience. A summary of the most useful systematic characters has been placed at the end to assist in confirming identifications made by the key.

GENUS LAMPROPELTIS FITZINGER

Diagnosis: Maxillary teeth 12 to 20, solid, slightly increasing or slightly decreasing in size posteriorly, subequal or the last two a little enlarged; mandibular teeth decreasing in size posteriorly; head usually not or but slightly distinct from the neck; eye moderate, with round pupil; scales smooth, with two apical pits, in 17 to 27 rows; anal plate entire; tail moderate; caudals in two rows.

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[1] Contributions from the Department of Zoology, University of Michigan.

SYNOPSIS OF THE FORMS OF LAMPROPELTIS

a^1. Pattern of narrow cross bands of black, the alternate bands mixed or split with red; ground color above, slate gray; head very distinct from neck. *L. alterna* (Brown).

(Davis Mountains, Texas.)

a^2. Pattern not of narrow dorsal cross-bands of black with the alternate bands mixed or split with red; head usually only slightly distinct from neck.

b^1. Color pattern without red[2] and without dorsal blotches of brown or gray with black borders. . . . . Getulus group.

c^1. Scales chiefly black with sharply defined white or yellow spots (not light at base shading gradually into a dark distal border), these yellow spots often so grouped as to form 50 or more narrow cross bands on body and tail.

d^1. Scale rows on middle of body 23 or 25; no light centers, dorsally, on the scales between the cross-bands; head mostly black. *L. getulus splendida* (Baird and Girard).

(Southeastern Arizona to the ninety-seventh meridian; southern Texas, and northern Mexico.)

d^2. Scale rows on middle of body usually 21.

e^1. A yellow spot on practically all of the dorsal scales. *L. getulus holbrooki* (Stejneger).

(Eastern Texas to southeastern Wyoming, east to eastern Illinois, and south to the Gulf of Mexico.)

e^2. Scales between the dorsal cross-bands without light centers or with only a very few small ones. *L. getulus niger* (Yarrow).

(Eastern Illinois to Ohio, south to central Alabama.)

c^2. Pattern in rings, cross-bands, or stripes, or chiefly of scales white at base shading gradually into a black distal border, but not chiefly of sharply defined white or yellow spots on black scales.

f^1. Posterior chin shields nearly as long and nearly as wide as anterior, in contact or separated by not more than one small scale; pattern neither of rings nor of longitudinal stripes.

g^1. Many dorsal cross-bands of white or yellow.

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[2] The red fades to whitish in alcohol, but it is sufficient, for the purpose of the key, to determine that the pattern is in two colors instead of in three.

h^1. Cross-bands less than 50; 21 (sometimes 23) rows of scales. . . . . . *L. getulus getulus* (Linnaeus).
(New Jersey to Mobile Bay and central Florida.)

h^2. Cross-bands more than 50, or nearly indistinguishable; 23 (sometimes 21) rows of scales; scales between the cross-bands usually white at base.
L. getulus floridana Blanchard.
(Central to southern Florida.)

g^2. No dorsal cross-bands distinguishable; dorsal scales light at base, shading gradually into a dark distal border. . . . . . *L. getulus brooksi* Barbour.
(Extreme southern Florida.)

f^2. Posterior chin shields generally much shorter and narrower than anterior and separated by one or two small scales; pattern of rings, or of longitudinal stripes of white or yellowish.

i^1. A dorsal longitudinal stripe, complete or interrupted.

j^1. Dorsal stripe white or yellow, sharply defined on a dark brown or black ground color.
L. californiae californiae (Blainville).
(Fresno County, California, to northern Lower California.)

j^2. Dorsal stripe poorly defined, of light brown or cinnamon on a dark-brown ground color; belly uniform brown.
L. californiae nitida (Van Denburgh).
(Southern Lower California.)

i^2. Pattern of rings.

k^1. White scales[3] white to their bases, forming rings of uniform white; white bars on prefrontals broad, convex behind; infralabials usually 9.
L. getulus boylii (Baird and Girard).
(California, Nevada, southwestern Utah, northern and western Arizona, and northern Lower California.)

k^2. White scales[3] mostly brown at their bases. White bars on prefrontals broad or narrow. Infralabials 9 or 10.

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[3] Specimens may be found which can be accurately identified only by locality; in particular it should be noted that young examples of *yumensis* and *conjuncta* may resemble *boylii*.

l¹. White bars on prefrontals occupying less than half the area of these scutes; frontal plate uniform black, or with the white restricted to a narrow transverse bar at its anterior end; no white on parietals; infralabials usually 9. . . . . . *L. getulus yumensis* Blanchard.

(Southern Arizona, extreme southeastern California, northeastern Lower California, and northwestern Sonora.)

l². White bars on prefrontals occupying more than half the area of these plates; frontal plate with prominent white markings, or at least with a central spot of white; each parietal with one or more white spots; infrabials usually 10. . . . . . . *L. getulus conjuncta* (Cope).

(Southern Lower California.)

b². Pattern with red, or with dorsal blotches of brown, gray, or red, with black borders.

m¹. Pattern of black-edged dorsal blotches of brownish or dark red, only narrowly in contact with the fifth row of scales or extending no lower than the sixth or seventh rows. . . . Calligaster group.

n¹. Blotches less than 40. . . . . *L. leonis* (Günther). (Nuevo Leon, Mexico.)

n². Blotches 45 to 80.

o¹. Scale rows 25 to 27 on middle of body; dorsal blotches with concave anterior and posterior margins; infralabials 9 or 10, rarely 8. . . . . *L. calligaster* (Harlan).

(Western Texas to Mississippi, north to Indiana and northwest to Minnesota, thence south to Texas.)

o². Scale rows 23 or 21 on middle of body; dorsal blotches with straight or convex anterior and posterior margins; infralabials 8, less often 9. . . *L. rhombomaculata* (Holbrook).

(Mobile, Alabama, to Knoxville, Tennessee, north to Maryland, and south to central Florida.)

m². Pattern in rings; or, if in blotches or saddles of brown, gray, or red, these broadly in contact with the fifth or a lower row of scales.

p¹. Whitish cross-bands on body and tail less than 40; or, if more than 40, the snout not uniformly whitish.

q¹. Whitish cross-bands little if any widened on the lower rows of dorsal scales, and the scale rows more than 17 on the anterior portion of the body.

r¹. Red scales usually tipped with black.

s¹. Snout black, with usually a light transverse bar on or near the prefrontals; two temporals in the first row; caudals usually not less than 49. . . . . *L. polyzona* Cope.

(Southern Mexico to Costa Rica.)

s². Snout yellowish with transverse black spots; a single, anterior temporal, or, if two, the upper much the smaller; caudals not more than 49.

L. micropholis Cope.

(Panama to Colombia and Ecuador.)

r². Red scales not tipped with black.

t¹. Whitish annuli usually more than 30; snout black.

u¹. Ventrals more than 200; black rings often meeting across the red dorsally.

L. multicincta (Yarrow).
(California.)

u². Ventrals less than 200; black rings not meeting across the red dorsally.

L. ruthveni Blanchard.
(Southern Mexico.)

t². Whitish annuli less than 30.

v¹. Dorsal red areas usually continuous across the belly; snout whitish, specked with black.

w¹. Ventrals usually more than 210 (199 to 231).

L. triangulum nelsoni Blanchard.
(Western Mexico.)

w². Ventrals usually less than 200 (180 to 212).

L. triangulum amaura (Cope).
(Lower Mississippi Valley.)

v². Spaces on belly between the yellow rings filled with black; snout totally black, or only very slightly lightened on the top or sides.

x¹. Yellowish rings 19 to 25: black spaces on belly usually longer than the intervening yellow ones.

L. triangulum annulata (Kennicott).

(Plateau region of southern Mexico north to extreme southern Texas.)

x². Yellow rings 25 to 40; black spaces on belly usually shorter than the intervening yellow ones.

L. triangulum gentilis (Baird and Girard).

(South central Texas to South Dakota, west into Utah and Arizona.)

q². Dorsal whitish bands usually distinctly widened on the first row of scales, or the scale rows anteriorly not more than 17.

y¹. Black practically uniform over the head, except for the snout region, which is more or less lightened, at least on the sides; scale rows anteriorly more than 17.

z¹. Whitish annuli or cross-bands 25 to 40; black often strongly encroaching upon the red on the mid-dorsal line.

L. triangulum gentilis (Baird and Girard).

z². Whitish annuli or cross-bands 18 to 25; black showing not more than a slight tendency to encroach upon the red areas on the mid-dorsal line.

L. triangulum amaura (Cope).

(Lower Mississippi Valley.)

y². Black of head practically restricted to posterior portion, or to various black-edged light markings.

aa¹. Usually a single anterior temporal; scale formula generally 17–19–17, rarely higher than 19–17.

bb¹. Red areas continuous across the belly.

L. elapsoides elapsoides (Holbrook).

(North Carolina and Kentucky, south to New Orleans and throughout Florida.)

bb². Red not continuous across the belly, but restricted to black-bordered dorsal saddles that extend upon the ventrals.

L. elapsoides virginiana Blanchard.

(Northern North Carolina to Delaware.)

aa². Usually two anterior temporals; scale formula very rarely lower than 19-21-19–17.

cc¹. Whitish annuli or cross-bands 18 to 23; pattern of body practically in rings. . . . . . *L. triangulum amaura* (Cope).

(Lower Mississippi Valley.)

cc². Whitish cross-bands 23 to 60; pattern of dorsal saddles or blotches of red or brown.

dd¹. Infralabials 8 or 9, rarely 10; tail less than 16 per cent of total length; often a dark band from eye to angle of mouth.

ee¹. Dorsal saddles 35 to 60, reaching down to the fifth or third row of scales; often two rows of lateral alternating blotches; a dark band on posterior portion of prefrontals; a black-bordered light band from the eye to the angle of the mouth; usually a Y-shaped light spot on the back of the head. . *L. triangulum triangulum* (Lacépède).

(Eastern United States and southern Canada.)

ee². Dorsal saddles 23 to 35, extending down to the third row of scales, or lower; only one series of alternating spots; head markings of *triangulum* only partially or not at all developed. . . . *L. triangulum syspila* (Cope).

(Southern Indiana to Minnesota, south to central Arkansas and west to central Kansas.)

dd². Infralabials 10; tail more than .16 of total length; a dark blotch behind the eye. . . . . *L. mexicana* (Garman).

(San Luis Potosi, Mexico.)

p². Whitish cross-bands on body and tail more than 40; top of head black, snout uniformly white. . . . . . . *L. pyrrhomelaena* (Cope).

(Utah, Arizona, western New Mexico, and northern Mexico.)

	Tail Divided by Total Length	Pattern	Number of Bands or Spots
	.170	Alternating bands	
	.118—.156	Rings	18–26
	.123—.167	Rings	19–26
	.107—.145	Rings	28–49
..	....	No bands or rings	....
	.113—.140	Stripes	....
	.110—.150	Blotches	46–78
	.115—.132	Rings	30–40
	.118—.169	Rings	15–25
	.107—.146	Cross-bands	46–85
	.115—.156	Rings	25–40
	.100—.155	Cross-bands	23–52
	.096—.150	Cross-bands	50–100
	....	Blotches	27
	.16—.17	Blotches	39
	.112—.136	Rings	13–21
7	.131—.161	Rings	23–57
	.120—.150	Rings	13–24
	.110—.146	Narrow bands	50–90
...	....	Stripes'	....
	.124—.164	Rings	17–37
	.153—.182	Rings	35–71
	.100—.150	Blotches	48–64
...	....	Rings	30+
	.100—.150	Light cross-bands	41–85
	.114—.157	Blotches	23–36
	.100—.155	Blotches	28–62
	.090—.140	Rings	29–45
	.129—.145	Blotches	18–27

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SUMMARY OF CERTAIN CHARACTERISTICS OF THE FORMS OF LAMPROPELTIS*

NAME	VENTRALS	CAUDALS	SUPRA-LABIALS	INFRALABIALS	TEMPORALS	SCALE ROWS		TAIL DIVIDED BY TOTAL LENGTH	PATTERN	NUMBER OF BANDS OR SPOTS
						Extremes	Average			
alterna	213	60	7	10–11	3+4	25-23-25-23-21		.170	Alternating bands	
amaura	180–212	39–51	7	9(8–10)	2+3	21-23-21-19- to 19-21-19-17	21-19	.118—.156	Rings	18–26
annulata	197–212	40–57	7(8)	9(10)	2+3	23-21-19-21- to 21-20-21-19	21-19	.123—.167	Rings	19–26
boylii	206–254	41–62	7(8)	9–10	2+3	23-25-23-21-19- to 21-23-21-19	23-21-19	.107—.145	Rings	28–49
brooksi	Similar to floridana	Similar to floridana							No bands or rings	
californiae	229–241	47–60	7–8	(8)9–10	2+3	23-25-23-21-19 to 21-23-21-19	23-21-19	.113—.140	Stripes	....
calligaster	196–215	38–57	7(8)	9–10	2+3	25-27-25-23-21 to 21-23-21-19	23-25-23-21-19	.110—.150	Blotches	46–78
conjuncta	228–240	48–54	7	10(9–11)	2+3	23-25-23-21-19 to 21-23-21-19	23-21-19	.115—.132	Rings	30–40
elapsoides	152–193	32–48	7	8(7–9)	1+2	19-21-19-17 to 15-17-15	17-19-17	.118—.169	Rings	15–25
floridana	210–225	42–55	7(8)	9–10	2+3	23-21 to 21-19	21-23-21-19	.107—.146	Cross-bands	46–85
gentilis	176–212	41(31)–53	7(8)	9(8–10)	2+3	23-21- to 19-17	21-19	.115—.156	Rings	25–40
getulus	203–224	38–58	7(6–8)	9(8–10)	2+3	23-21 to 19-21-19-17	21-19 or 21-23-21-19	.100—.155	Cross-bands	23–52
holbrooki	200–220	38–55	7(6–8)	9(8–10)	2+3	21-23-21-19 to 19-17	21-19 or 19-21-19	.096—.150	Cross-bands	50–100
leoni	200	50	7	....	2+3	....	23	....	Blotches	27
mexicana	193–199	55	7	10	2+3	23-21-19	23-21-19	.16—.17	Blotches	39
micropholis	211–228	42–49	7(8)	9–8(10)	1+2 to 2+3	21-23-21-19 to 19-21-19-17	19-21-19-17	.112—.136	Rings	13–21
multicincta	202–222	45–61	7(8)	9(8–10)	2+3	23-25-23-21-19 to 21-19-17	21-23-21-19 or 21-19-17	.131—.161	Rings	23–57
nelsoni	199–231	42–59	7(8)	9(10)	2+3	21-23-21-19 to 19-21-19-17	21-19-17	.120—.150	Rings	13–24
niger	199–216	41–53	7	9(8–10)	2+3	21-23-21-19 to 19-21-19-17	19-21-19	.110—.146	Narrow bands	50–90
nitida	227	56	....	....	....	23	....	....	Stripes	
polyzona	208–239	42–61	7(8)	9(8–10)	2+3	21-23-21-19 to 19-17	21 or 23	.124—.164	Rings	17–37
pyrrhomelaena	216–235	61–70	7–8	9–10(11–12)	2+3	23-25-23-21-19 to 21-23-21-19-17	23-21-19	.153—.182	Rings	35–71
rhombomaculata	191–213	31–55	7	8–9	2+3	21-23-21-19 to 19-21-19-17	23 or 21	.100—.150	Blotches	48–64
ruthveni	190	52+	7–8	7–8	2+3	21-23-21-19	....	....	Rings	30+
splendida	207–225	43–56	7(8)	9(10–11)	2+3	23-25-23-21-19 to 21-23-21-19	21-23-21-19	.100—.150	Light cross-bands	41–85
syspila	180–215	42–54	7	9(8–10)	2+3	21-23-21-19 to 19-17	21-19	.114—.157	Blotches	23–36
triangulum	180–213	29–54	7(8)	9(8–10)	2+3	21-23-21-19 to 19-17	21-19-17	.100—.155	Blotches	28–62
yumensis	212–240	44–57	7(8)	9–10	2+3	23-25-23-21-19 to 21-23-21-19	23-21-19	.090—.140	Rings	29–45
virginiana	173–188	36–44	7	7–9	1+2	17-19-17 to 19-17	17-19-17	.129—.145	Blotches	18–27

* Figures in parentheses represent less common numbers

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NOTES ON THE ATHERINE FISHES OF COLOMBIA

By Carl L. Hubbs

Dr. Carl H. Eigenmann has kindly submitted to the writer several series of atherine fishes from Colombia. Two of the species represented in this collection are marine, well-known as tropical Atlantic forms, but never before recorded from the Pacific; in fact, neither of the two genera nor the subfamily (Atherininae) which they represent[1] have been noted heretofore in the eastern Pacific. The third form, *Thyrina colombiensis*, a new species, inhabits the basins of the Rio San Juan and the Rio Patia. No other atherine fish is known to occur in Colombia, but *Thyrina pachylepis* has been recorded from both Panama and Ecuador.

Hepsetia stipes (Müller and Troschel).[2]—An adult and several young specimens (Cat. No. 15306, Indiana University) of this species were collected by Arthur Henn and Charles Wilson at Tumaco, a port in southern Colombia. Comparison with Atlantic material discloses no constant differences.

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[1] Cf. Jordan and Hubbs, *A Monographic Review of the Family of Atherinidae or Silversides* (Stanford Univ. Publ., 1919), pp. 29, 31, 35.

[2] Cf. Jordan and Hubbs, *ibid.*, p. 34.

Atherina harringtonensis araea Jordan and Gilbert.[3]—A large series (Cat. No. 15307, Indiana University) characteristic of this subspecies was collected by Henn and Wilson at Tumaco, Colombia. Neither this form nor the preceding species has been recorded from the Pacific Ocean, and neither was mentioned by Mr. Wilson in his report[4] upon the collection of which this marine material comprises a part.

GENUS THYRINA JORDAN AND CULVER

Especially in view of the characters of the new species described below, *Atherinichthys pachylepis* can scarcely be regarded as typical of a genus (Thyrinops)[5] distinct from Thyrina.

Although probably not an unnatural unit, this genus comprises several sections, well distinguished by technical characters, and possibly worthy of subgeneric distinction.

DIAGNOSTIC ANALYSIS OF THE SPECIES OF THYRINA[6]

a¹. Belly less shortened, the origin of the anal fin about midway between head and caudal base in adult: *Atlantic slope from Venezuela to Brazil; Pacific slope from Costa Rica to Ecuador.*

b¹. Anal base decidedly longer than head; anal soft rays usually more than 20; pectoral fin more elongate, extending to or even beyond vertical from tips of pelvic fins; scales thicker, with numerous fine subparallel radii; scale margins strongly but rather finely laciniate; rami of mandibles rather strongly elevated posteriorly; air-bladder showing through the translucent flesh, and broadly extended backward a short distance into urosome: *salt and fresh waters from Costa Rica to Ecuador.*
Thyrina pachylepis (Günther).

b². Anal base about as long as head; anal rays usually fewer than 20 (16 to 21); pectoral fins less elongate (about as long as head), extending about to vertical from middle of pelvic fins; scales thinner, their margins entire or weakly laciniate; rami of mandibles little elevated posteriorly: *Colombia to Brazil.*

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[3] *Op. cit.*, p. 39.

[4] *Ann. Carn. Mus.*, 10, 1916, pp. 57–70.

[5] Hubbs, *Proc. Acad. Nat. Sci. Phila.*, 1917 (1918), p. 306; Jordan and Hubbs, *op. cit.* pp. 17, 61.

[6] For synonymies cf. Jordan and Hubbs, *op. cit.*, pp. 58–61.

c¹. Scales mostly marked with numerous though faint radial apical radii; scale margins usually weakly but finely laciniate; air-bladder not showing through the opaque flesh, scarcely extended backward into urosome; dorsal rays II or III, 6 or 7; spinous dorsal when depressed usually reaching less than halfway to origin of second dorsal: *salt and brackish waters from Lake Maracaibo, Venezuela, to Rio de Janeiro, Brazil.*
Thyrina brasiliensis (Quoy and Gaimard).

c². Scales mostly without, occasionally with a few widely spaced faint apical radii; scale margins either entire or slightly uneven, or weakly and coarsely laciniate; air-bladder showing rather faintly through the semitranslucent flesh, extended backward as a well-defined conical diverticulum in the urosome; dorsal rays III or IV, 7 to 9; spinous dorsal when depressed usually reaching more than halfway to origin of second dorsal: *San Juan and Patia rivers, Colombia.*
Thyrina colombiensis Hubbs.

a². Belly shortened, the origin of the anal fin much nearer head than caudal base; anal base decidedly longer than head; air-bladder showing through the translucent flesh, extended backward as a broad diverticulum in the urosome; anal rays 18 to 25: *lakes, rivers, and estuaries of Middle America.*

d¹. Mouth strongly oblique; rami of mandibles strongly elevated posteriorly; body only moderately elongate: *Great Lakes of Nicaragua.* . . . . *Thyrina sardina* (Meek).

d². Mouth little oblique anteriorly, but strongly curved downward posteriorly; rami of mandibles slender, little elevated within the mouth.

e¹. Snout decidedly longer than eye: *basin of the Motagua, Atlantic slope of Guatemala.* . . . . . *Thyrina meeki* Miller.

e². Snout about equal in length to eye.

f¹. Depth of body less than one-sixth the standard length: *Atlantic coast streams of Costa Rica and Panama.*
Thyrina chagresi (Meek and Hildebrand).

f². Depth of body more than one-sixth the standard length: *Pacific coast slope of Mexico and Guatemala.*
Thyrina guatemalensis (Günther), *balsana* (Meek), *crystallina* Jordan and Culver, and *evermanni* Jordan and Culver.[7]

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[7] These species have lately been compared by Jordan and Hubbs, *op. cit.*, pp. 60, 61.

Thyrina colombiensis, new species

Holotype: Cat. No. 13871, Museum of Indiana University, a specimen 101 mm. long (without caudal) collected by Arthur Henn and Charles Wilson "from Barbacoas to 8 miles above," in the Rio Telembi, a tributary of the Rio Patia, on the Pacific slope of southern Colombia. The paratypes, varying in standard length from 19 to 104 mm., comprise series from the type locality; from Condoto, on the Rio Condoto, a tributary of the San Juan (13870, I. U.); from the Rio San Juan at Istmina (13868, I. U.), and at Tado, Colombia (13869, I. U.). A set of paratypes from the Rio Telembi is deposited in the Museum of Zoology of the University of Michigan (Cat. No. 55006). Three lots of specimens of this new form are deposited in the Carnegie Museum (7485, from Istmina; 7486, from Condoto; 7487, from the Rio Telembi).

Body with the form characteristic of Thyrina, a little more compressed than in *T. brasiliensis;* greatest depth, 4.9 (4.6 to 4.9)[8] in standard length; least depth of caudal peduncle about equal to postorbital length of head, or to the interorbital width. Length of head to angle of opercle, 4.4 (4.0 to 4.6); length of orbit, 3.5 (3.1 to 3.6). Snout a little longer than the orbit (orbit longer than snout in young), its rather sharply pointed and projecting tip on the horizontal passing through upper edge of pupil. Lower outer edge of mandible slightly concave, forming an angle of 45° with the horizontal; upper edge of mandible horizontal anteriorly and oblique but moderately elevated posteriorly (within the mouth); maxillary extended backward to vertically below front of posterior nostril. Teeth in rather narrow bands on the jaws; the outer series of the premaxillary, projecting downward from the edge of the lip, moderately enlarged; palate edentulous.

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[8] The measurements and counts in parentheses are those of twenty paratypes from the Rio Telembi, from Istmina and from Tado.

Gill-rakers slender, shorter than the pupil, 17 on lower limb of outer arch. Air-bladder rather faintly showing through the semi-translucent flesh, extended backward as a well-defined and bluntly pointed diverticulum into the urosome over the anal base.

Scales in 41 (38 to 41) rows from gill-opening to end of hypural; mostly without, but occasionally with a few widely spaced and rather indistinct apical radii; scale margin either entire or slightly uneven, or coarsely yet weakly laciniate.

VARIATION IN THE NUMBER OF ANAL RAYS IN FOUR SERIES OF *Thyrina colombiensis*

Locality	Anal soft-rays					
	16	17	18	19	20	21
Rio Telembi (Patia basin)	......	3	18	5	......	1
Condoto (San Juan basin)	......	2	3	......	......	......
Tado (San Juan basin)	......	1	4	1	......	......
Istmina (San Juan basin)	3	7	3	3	......	......
Totals	3	13	28	9	......	1

Dorsal rays III (or IV), 8 (7 to 9); anal rays, I, 19 (16 to 21: see table). Spinous dorsal located a little behind vertical from front of anal fin, when depressed extending nearly two-thirds (to about one-half) the distance to the origin of the second dorsal; second dorsal with a short base (about equal to postorbital length of head), extended backward about to vertical from end of anal base. Anal base shorter than in other species of Thyrina excepting *T. brasiliensis*, only about as long as head; anal edge falcate. Origin of anal fin about midway between head and base of caudal, considerably more anterior in relative position in young. Pectoral fin about as long as head (usually slightly longer than head in the Telembi series, slightly shorter than the head in the lots from the San Juan basin); length of pectoral contained 4.2 (3.9 to 4.3) times in standard length in the Telembi series, 4.0 to 4.5 times in the Istmina and Tado series.

Like the other species of the genus, *T. colombiensis* is a silvery fish, the color darkening on the back and on the front of the jaws to a purplish brown (in alcohol); regions over orbits, premaxillaries and occiput blackish. Dorsal and caudal fins, the base of the anal, and the upper edge of the pectoral fin darkened.

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REPORT ON INVESTIGATIONS OF THE FISH OF THE GALIEN RIVER, BERRIEN COUNTY, MICHIGAN

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During the progress of the ichthyological survey of the waters of Michigan being made by the writer for the Michigan Geological and Biological Survey under the direction of Dr. A. G. Ruthven, Chief Naturalist of the Survey, attention has been given to the fish of the Galien River because the stream flows through the Warren Forest Preserve, in Berrien County, Michigan, a region being especially studied by the Survey and the Museum of Zoology, University of Michigan, in co-operation with the Chamberlain Memorial Museum at Three Oaks.

The field work on fish giving data for this paper was done by the writer from June 1–8, from August 27–29, 1919, and on June 7, 1915. In the work done in 1919, the writer was given much useful assistance by George M. Fox, Director of the Chamberlain Memorial Museum, principally through providing transportation and giving suggestions valuable in the work. Mrs. Hankinson aided considerably by making field records while the collecting was going on. Information useful to the writer in these investigations was given by N. A. Wood and Dr. Lee R. Dice, both of the Museum of Zoology, University of Michigan, and by J. C. Kraemer, Frank Sawyer, and A. Whitmayer, all three of whom are residents of the region and familiar with the fish there. Small examples of a few species of fish could not be identified by the writer, and these were named for him by Henry W. Fowler, of the Academy of Natural Sciences of Philadelphia. Miss Ada Weckel, of Oak Park, Illinois, identified the amphipods collected.

Very little attention has apparently been given heretofore to the fish of the Galien River, for the only references to literature on the fish of the stream that can be found are those that pertain to plantings of brook trout, wall-eyed pike, and small-mouth black bass (*Reports of the State Board of Fish Commissioners of Michigan* for 1905, p. 28; 1913, p. 22; 111; and 1915, p. 81).

The Galien River is a small river arising from many streams and lakes in the southern third of Berrien County, chiefly south of Lighton, east of New Buffalo, and west of Buchanan, and entering Lake Michigan at New Buffalo (map, Fig. 1). The south branch, which is its most important tributary, joins the main stream near Union Pier. The Warren Woods are about seven miles up the stream from the mouth; and the river here was given especial attention, but collections were made in a number of its other parts. Each of the places fished was given a number and called a station. The stations outside the woods are located as accurately as possible on the accompanying map. The numbers used are not consecutive so that others may be added for future work, using the same notation. The stations are listed below with a brief description of each.

Station 1.—Mouth of the Galien River at New Buffalo, where the river cuts through the broad, low, sandy beach of Lake Michigan. Here the stream expanded from a usual width of about a

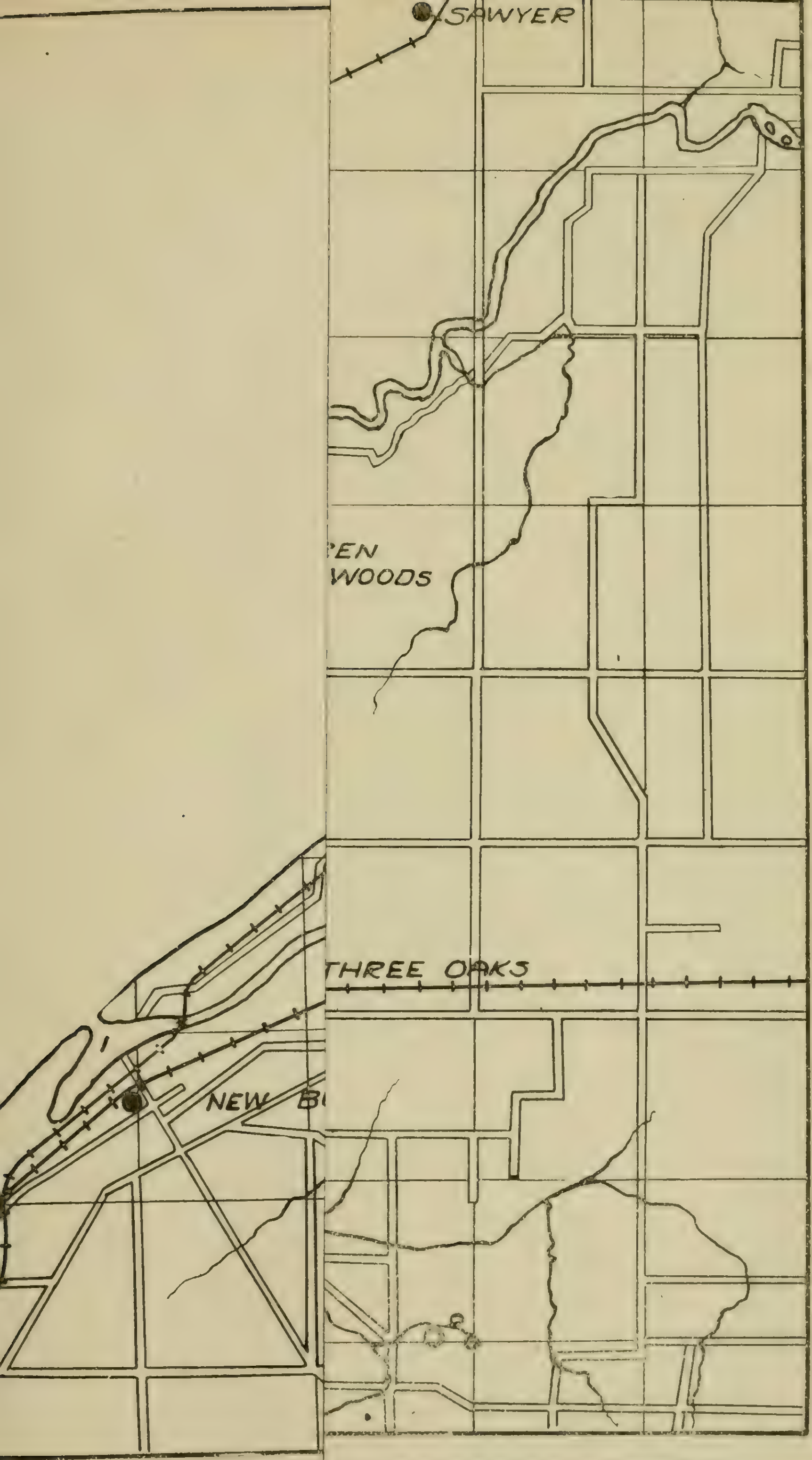

Fig. 1.—Map of southwest po

locate stations outside of the Warren Woods.

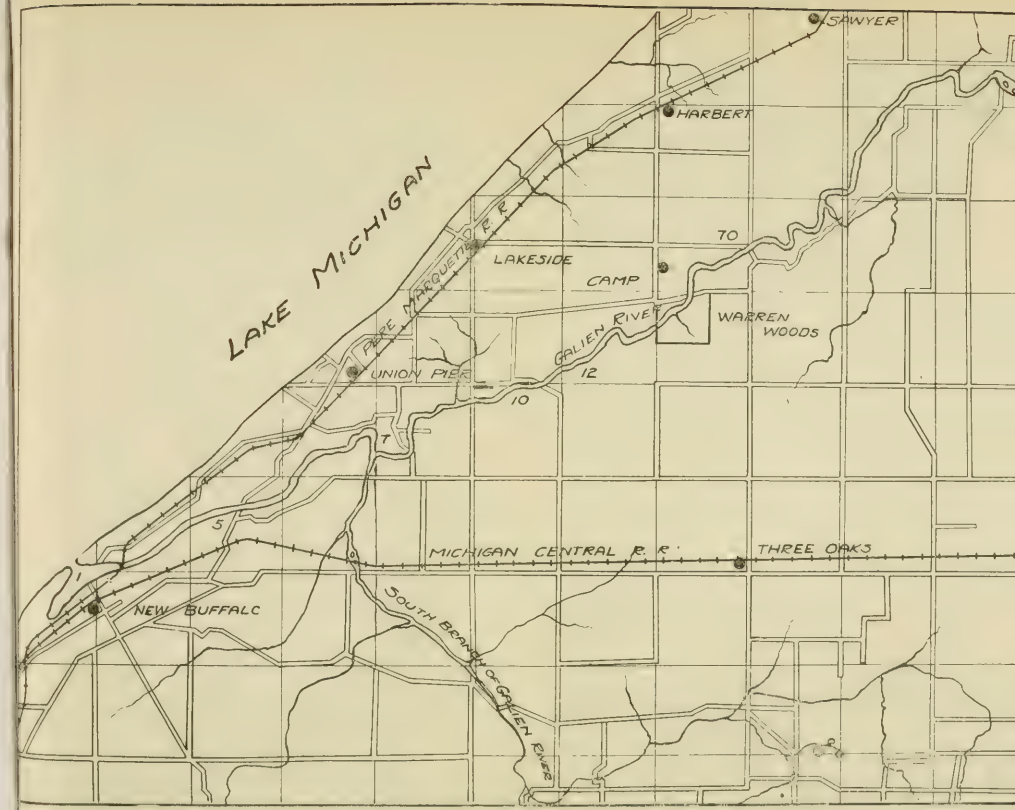

FIG. 1.—Map of southwest portion of Berrien County, Michigan, showing lower course (about twelve miles) of the Galien River. Numbers locate stations outside of the Warren Woods. Modified from the U.S. Postal Map.

hundred feet to nearly two hundred feet; and this expansion had a broad, shallow area where wading and fish collecting could be easily done, and here all the fish collections were made. The region was visited but once, on June 7, 1915.

Station 5.—Plate I, Fig. 1. Part of the river near the rock road bridge, a mile and a half southwest of Union Pier. The stream was about a hundred feet wide here and was sluggish and running through a broad strip of uncultivated flood plain. It was shallow with firm clay bottom and had little evident water vegetation, except patches of a fine-leaved pondweed, *Potamogeton* and some water lilies. In places along the bank were rows of large willows overhanging the stream. The station was visited on August 27, 1919.

Station 7.—Plate I, Fig. 2. Junction of the north and south branches of the Galien River about a mile south of Union Pier. The stream was broad and so shallow that it could be waded everywhere. There were some broad gravel beaches due to low water bordering a broad stream area with muck bottom and a thick growth of a broad-leaf pondweed, making a place more favorable for small fish than any other place of its size that we found in the river. The station was visited on August 27, 1919.

Station 10.—Galien River near the bridge about two miles east of Union Pier. The water was deep, sluggish, turbid, and much shaded by high banks and large trees and by the bridge. The station was visited on August 27, 1919.

Station 12.—Plate II, Fig. 1. Galien River about a quarter of a mile above Station 10. The stream was narrow and shallow with firm sand bottom; the water was clear and with a marked current. Large tufts of a narrow-leaf pondweed were present. The station was visited on August 27, 1919.

Station 25.—Plate III. River at the bend at the mouth of the creek in the south part of Warren Woods. The stream was from thirty to forty feet wide and was more than half-crossed by the gravelly creek delta. An old sand dune was cut through by the river, making a portion of each shore high and sandy; elsewhere it was of clay. There was no noticeable aquatic vegetation here or elsewhere in the river through the woods. The station was visited a number of times, but collecting was done only on August 28, 1919.

Station 26.—Plate II, Fig. 2. Mouth region of a small creek in the south part of the Warren Woods, called Sycamore Creek and entering the Galien River at Station 25. This lower part of the creek winds through a broad, grassy glade. It contained little water at any time that it was visited, which was in June and August' 1919. At the latter time, when the collections were made, it was composed of pools that were practically stagnant and were connected by narrow, trickling streamlets. The water was turbid. The bottom was of gravel and firm clay. High overhanging, commonly grassy, banks were present.

Station 30.—Plate IV, Fig. 1. Galien River in Warren Woods in the vicinity of two large trees fallen across the river about fifty feet apart. The place was called Two Bridges by our investigating party. The stream cuts through a large sand bank here leaving a high, sandy cliff on the west side and a piece of sloping sandy shore on the east side; the other banks are of clay. At the upper part of the station was a broad pool, about four feet deep, lying just above the upper tree bridge. The water was shallow between the two bridges, with a marked current and with a sand and gravel bottom; some bowlders and sunken logs were present. The place was visited frequently and a number of collections made in both June and August.

Station 46.—Plate V, Fig. 1. A small, winding stream in a narrow, rather deep ravine in the north part of the Warren Woods, just north of the main road. The stream joins the river near the bridge on the main road. In August this stream was dried up except for a few deep, stagnant pools. The bottoms of these were of hard clay and gravel. Collections were made here on August 27, 1919.

Station 50.—Plate V, Fig. 2. Galien River above bridge of main road at the Warren Woods and upstream about a quarter of a mile as far as the east bank was cleared. The east bank was sandy. The stream at this station was about thirty feet wide on the average and its depth mostly under four feet. The bottom was mostly of firm, slippery clay and usually sloped abruptly toward the middle of the stream. Collections were made here on June 1, 1919.

Station 70.—Galien River near the rock road bridge about a half-mile northeast of the Warren Woods. The stream flows through low, shrubby pasture land and was bordered with many willows and much herbage along its margin. It was rather narrow, averaging about twenty feet. The water was high, rapid, and turbid on June 5, the time the station was visited. The bottom was mostly of hard clay. Some pools and small sloughs were close to the stream, none of which were found connected with the river, but must have been at times of very high water.

LIST OF SPECIES

The most important facts concerning each species of fish found in the Galien River and some of its tributaries are here given. A number of species other than those found by the writer certainly occur in the river. Small-mouthed black bass and wall-eyed pike are reported from the stream, and both have been planted in it near New Buffalo. None of the Siluridae were taken, but bullheads are said to be occasionally caught. Eels, dogfish, and buffalo fish are reported to be found in the river at times. A small lamprey, *Ichthyomyzon sp.*, four and a half inches long, was found clinging to a rock in shallow, swift water at Station 30. The small size and immature condition of the specimen makes its determination at present impossible.

The list is undoubtedly more complete for species represented in the streams by small individuals than for those with large ones, since methods primarily for collecting large fish were little used, most of the collecting being done with minnow seines.

1. *Hypentelium nigricans* (LeSueur), Hog Sucker.—Apparently scarce in the river. A small one taken at Station 7.

2. *Catostomus commersonii* (Lacépède), Common Sucker.—Two small ones under five inches long taken in Sycamore Creek, Station 26. None of mature size were taken or noted, but Frank Sawyer says that suckers (very probably this species) are abundant in the river in early spring at their spawning time.

3. *Minytrema melanops* (Rafinesque), Spotted Sucker.—One small one, two inches long, taken in August, at Station 26.

4. *Moxostoma aureolum* (LeSueur), Common Red Horse.—One young one, two inches long, taken at Station 7.

5. *Moxostoma duquesnei* (LeSueur), Fine-scaled Red Horse.—A young one two inches long caught at Station 26.

6. *Cyprinus carpio* Linnaeus, Carp.—A small one nearly four inches long of the scaled variety was taken in Sycamore Creek, Station 26. Frank Sawyer says carp are abundant in the river in the spring and follow the suckers at their spawning time and probably eat the spawn.

7. *Campostoma anomalum* (Rafinesque), Stone Roller.—One taken in Sycamore Creek in August, 1919.

8. *Pimephales notatus* (Rafinesque), Blunt-nosed Minnow.—Abundant and generally distributed in the river but most common in the shallower water and where the bottom is stony (Station 30) or sandy (Station 12) or where there is much aquatic vegetation (Station 7). Not many places with these especially favorable conditions for the species were found in the part of the river examined.

The minnow breeds in the Galien River. Egg patches were found in June on the flat undersides of objects on the bottom;

one patch was under a board and one under an old shovel blade and one under a cook-stove top. Each patch of eggs was oblong with the longest diameter nearly six inches; each was attended by a large male of the species about three and a half inches long with body highly charged with black pigment, especially intense on the head. Two of them captured had each sixteen tubercles or pearl organs arranged in three horizontal rows on the snout. The attending fish were as usual very bold in defense of their eggs and hence were easily caught.

The eggs on the shovel blade were left as they were found after the male fish watching them had been taken, and the next day they were all gone, very probably eaten by crayfish or minnows.

9. *Semotilus atromaculatus* (Mitchill), Creek Chub.—Many were found in the river but these were all small ones, none much over two inches in length. Larger ones, four to five inches long, were caught in August in the pools of the ravine stream in the woods, Station 46.

10. *Notemigonus crysoleucas* (Mitchill), Golden Shiner.—Apparently scarce in the region. A few taken in the river at Station 30 and a few from the small stream, Station 26. One caught in a slough, at Station 70, in June. All taken were small fish under three inches in length.

11. *Notropis blennius* (Girard), Straw-colored Minnow.—Taken only at Station 1, at the mouth of the river.

12. *Notropis hudsonius* (Clinton), Spot-tail Minnow.—Taken in the river at Station 1 and not elsewhere in the stream.

13. *Notropis whipplii* (Girard), Silver-fin Minnow.—Found at the mouth of the river, Station 1, and not elsewhere in the stream.

14. *Notropis cornutus* (Mitchill), Common Shiner.—The most abundant and most generally distributed minnow in the part of the Galien River fished. Large examples were uncommon, and these were confined to rather definite and rather unusual conditions in the stream where the water was clear and rapid and where the

bottom was gravelly or sandy; these conditions were found only at Stations 12 and 30.

At Station 30 on June 3, 1919, the spawning act in this species was witnessed by the writer many times. Here a large male common shiner about five inches in length and in high coloration was maintaining a position over a growing pile of stones that was being built up by a busy river chub, in a manner to be described. The males of these two species were apparently not disturbed in the least by each other's activities, but the shiner gave much attention to a gathering of smaller members of his species that were undoubtedly all or nearly all females. He would swim out among them and attempt to drive them over the pile; and when successful, he would forcibly apply a side of his body to a side of one of the females. The contact would be maintained for but an instant when the two fish would separate. The female when released would float for a few seconds as the female horned dace does (Reighard, 1910, p. 1131) apparently exhausted by the spawning act. In this embrace the positions of the two sexes were very similar to those described by Reighard for the horned dace (*op. cit.*); the female is applied obliquely to the male with the head up while he keeps about the usual horizontal position. Sometimes the female was brought against the right side and sometimes the left side of the male shiner. Once another large male in breeding garb came near, but the one constantly occupying the pile drove him away by darting quickly to his side and then turning and striking him or at him with a head-on thrust. An attempt was made to collect some of these breeding shiners, but only one of them was taken and that a female distended with eggs, which were running from her body.

15. *Notropis atherinoides* Rafinesque, Emerald Minnow.—Scarce; one taken at the mouth of the river and one at Station 70.

16. *Notropis rubrifrons* (Cope), Rosy-face Minnow.—Uncommon in the river; a few taken at each of four stations (7, 12, 25, 30).

A male in breeding attire was caught on the gravelly shoal at Station 30 on June 3, 1919. This fish was about three inches long and flushed with red dorsally, the red being especially brilliant on the head. Every scale on the body except those immediately along the ventral line had several small, granular pearl organs at its exposed margin.

17. *Hybopsis kentuckiensis* (Rafinesque), River Chub.—Abundant and quite generally distributed in the river, but large individuals appeared scarce, and these were found at but one place, Station 30, where there were breeding activities by males on a gravelly shoal. A deep hole under a log near the upper log bridge was being used by them for a retreat. Three nests in the form of low, roundish, dome-shaped piles of small stones, were in the shallow water here. The piles were about a foot across and a few inches high, and the stones in them were quite uniform in size, being nearly an inch in thickness on the average and ranging from about a half-inch to two inches in greatest diameter (Pl. IV, Fig. 2). These nests were from two to ten feet out from shore and in water ranging from six inches to a foot in depth.

On June 3, I watched the building of one of these nests by a large male fish, probably seven inches long, adorned with red ventrally and with prominent pearl organs on the snout. My presence on the log bridge over the stream about eight feet from the nest was disregarded by the working fish a few minutes after I had taken my seat, and he worked incessantly for the hour or more in the early afternoon that he was under observation. During the time he built about a third of the nest, and this was evidently completed before sundown, for the next morning it had the size and form of other completed nests of the species, and a hard rain following the afternoon of the observations so raised the water and increased the current at the nesting spot that it is not at all likely that the fish could have worked under the changed conditions. The completed pile was about twenty inches in diameter and three or four inches high. When last seen at mid-afternoon on June 3, it was about a foot in diameter and not nearly so high.

During the period of my observations the fish carried stones to the pile holding them in his mouth, laboring in an active and tireless way, making dozens of excursions usually up stream and obtaining the stones chiefly from points two or three feet away. Stones as large as two inches in diameter were brought at times, but with such loads the fish would enter the strongest part of the current and allow this to assist him. Only once was he seen to drop a stone short of the pile. At one time he worked at the center of the pile as if trying to make a little pit in it. Spawning was not observed; in fact no other creek chubs were at the place except a few very small ones associated with the little common shiners, and perhaps other minnows, that were schooling near the nest.

About eight feet away from this nest, however, another large male river chub was building a stone pile. At one time the two males met and a little combat ensued, ending in one applying its side to the back of the other and holding the position for a second or two. Possibly this was the spawning position of the species assumed through the mistaking of sex.

18. *Umbra limi* (Kirtland), Mud Minnow.—None were found in the river but some were taken in both of the tributary creeks in the Warren Woods, Stations 26 and 46.

19. *Esox lucius* Linnaeus, Common Pike.—Three taken, two rather large, thirteen to fifteen inches long, at Stations 25 and 30 and one small one three inches long from Station 50. The one from Station 25 was taken by hook in August with a minnow as bait. They are said to reside in deep holes in the river where anglers obtain considerable sport in fishing for them and where they occasionally catch large ones, as large as seven and a half pounds according to Mr. Sawyer. The pike are quite generally blamed for the scarcity of large minnows, suckers, and some other fish in the river.

20. *Esox vermiculatus* Valenciennes, Little Pickerel.—Many were present in the river, and a few were found in Sycamore Creek near its mouth (Station 26). They rest, apparently in ambush for prey, commonly under bushes or other shore vegetation overhanging the water.

21. *Aphredoderus sayanus* (Gilliams), Pirate Perch.—One taken at Station 7, the junction of the two branches of the Galien River, from the muddy bottom area with pondweed patches (Plate I, Fig. 2).

22. *Pomoxis sparoides* (Lacépède), Calico Bass.—One taken from among floating brush in about four feet of turbid water at Station 50.

23. *Ambloplites rupestris* (Rafinesque), Rock Bass.—A few taken in each of five different stations, and these fish were all very small, under two inches in length, except one rather large example eight and a half inches long, which was caught at Station 12 by drawing the net through a thick pondweed tuft in rapid, clear water.

24. *Eupomotis gibbosus* (Linnæus), Common Sunfish.—Three caught along the shore of the river at Station 5.

25. *Micropterus salmoides* (Lacépède), Large-mouthed Black Bass.—Three small ones, three to three and a half inches long, taken at three different stations, 7, 10, and 12. All were dissected to determine the nature of the food, and each fish was found to have been feeding extensively on small water bugs, Corixidae. This appeared to be the only food in two of the fish, while one had remains of three small amphipod crustaceans in addition to many corixids in its alimentary canal.

26. *Percina caprodes* (Rafinesque), Log Perch.—One taken from under a log on gravel bottom of shallow water at Station 30.

27. *Hadropterus aspro* (Cope and Jordan), Black-sided Darter.—A few taken at each of four stations, 5, 7, 12, and 30, but common only at Station 12, where the bottom was sandy and the water comparatively rapid and clear.

28. *Bolcosoma nigrum* (Rafinesque), Johnny Darter.—Abundant at nearly all parts of the river fished; probably the most abundant species of fish in the stream. It seems to prefer sloping clay banks near the shore. In June a number of males in breeding dress were found. These were undersized compared with breeding males taken in other localities. They were about two inches long. No large examples of the species were found in the stream; the many caught measured from one and a quarter to two and a half inches in length. Few of the last length were taken, and the species was markedly dwarfed in the river.

29. *Poecilichthys caeruleus* (Kirtland), Rainbow Darter.—Only three taken, and these in June from the gravel bottom at Station 3. One was a male in high breeding coloration.

Conclusions

The Galien River in the Warren Woods and vicinity has a small fish fauna. Twenty-nine species were found in the stream, and twenty-one of them at the Warren Woods. There are probably but few other fish permanently inhabiting the river and its branches here, and there appear to be few food and game fish at least in summer, the common pike being the only one of these of sufficient size and numbers to attract anglers, and good strings of these are said to be obtained occasionally. In June the writer tried some line fishing and saw much of it, but no fish was seen caught in this way. In August a common pike was taken by a hook on a set line while it was being placed in the water.

Probably the paucity of good fish in the Galien River with conditions similar to those of the Warren Woods is principally due to the following causes:

a) Absence of much algae and other aquatic vegetation in the river or waters connected with it resulting in a scarcity of entomostracans or other small animals that furnish food for young fish and a limitation of breeding areas for fish needing plant-covered shallows for spawning or for protecting their eggs or young.

b) Small extent of gravelly shallows in the stream, apparently needed by many species for breeding areas.

c) Presence of numbers of large crawfish, *Cambarus virilis* and *Cambarus propinquus* in the river, which very probably destroy the eggs of fish, especially the ones that deposit them on the bottom or on plants or other places accessible to the crawfish. Fish like bullheads, sunfish, and black bass that actively protect their eggs would undoubtedly fail to keep them from the depredations of so many and so large crawfish. The species of fish that were well-established residents of river conditions like those in the Warren Woods were blunt-nosed minnow, creek chub, common shiner, river chub, and the common pike. These all place their eggs apparently quite safe from crawfish, under or among stones in case of the first four or in case of the common pike out in the shallow marshes early in the season before the period of much crawfish activity.

d) The presence of large common pike, which are well-known destroyers of other fish; and there were few shallows or stream mouths where small fish could escape the pike in the part of the Galien River examined.

e) Intensive fishing of the river by fishermen and anglers especially near its mouth, where many nets are said to be used.

The Galien River could undoubtedly be made artificially much more productive of large and desirable fish, which would be appreciated by the large number of people to whom the stream is readily accessible. It passes through a rather wild and very attractive region; and with more fish in it the recreative value of the little river would be increased. Large-mouthed black bass should thrive there with the abundance of crawfish food, and through reducing the numbers of these animals they would probably improve breeding conditions for themselves and other fish. There may, however, be an insufficiency of food for young bass, so there should be a better knowledge of their food in the stream preliminary to the planting of these fish as small as fingerlings. In the writer's brief survey, it was found that large-mouthed black bass about three inches long were eating water bugs, Corixidae, and large amphipods, *Hyallela knickerbockeri.* The latter were found to be very abundant in the river in June, when they were breeding, and there can be no doubt but that these crustaceans and the water bugs are an important fish food in the stream. Welch (1912) notes that corixids are often eaten by sunfish and minnows. A thorough study of the invertebrate life of the river at the Warren Woods, including a quantitative study of forms important as fish food, would probably give interesting and valuable results.

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PLATE I

Fig. 1.—Station 5. Galien River on flats near Union Pier, Michigan.

Fig. 2.—Station 7. Galien River at junction with South Fork near Union Pier, Michigan.

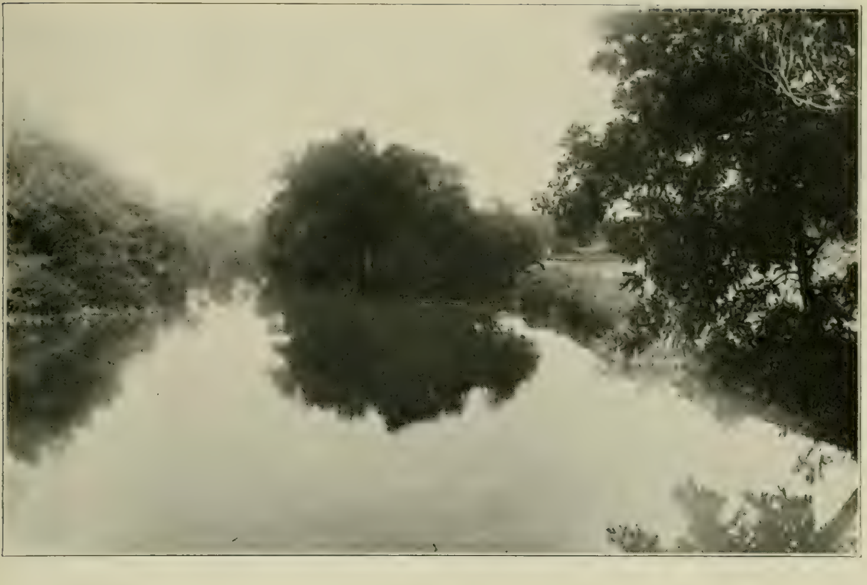

FIGURE 1

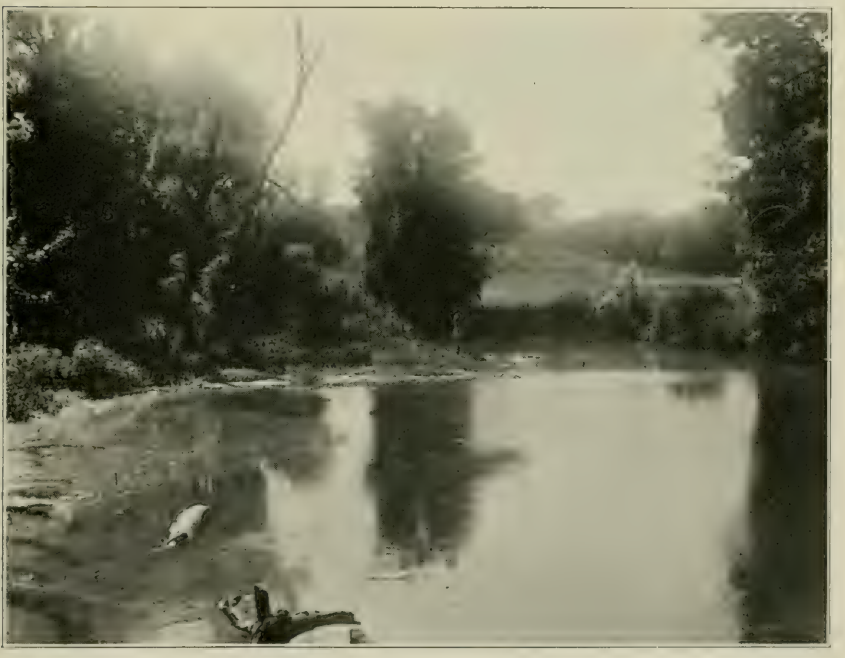

FIGURE 2

PLATE II

FIG. 1.—Station 12. Galien River about a mile southwest of the Warren Woods.

FIG. 2.—Station 26. Sycamore Creek, near its mouth, in Warren Woods.

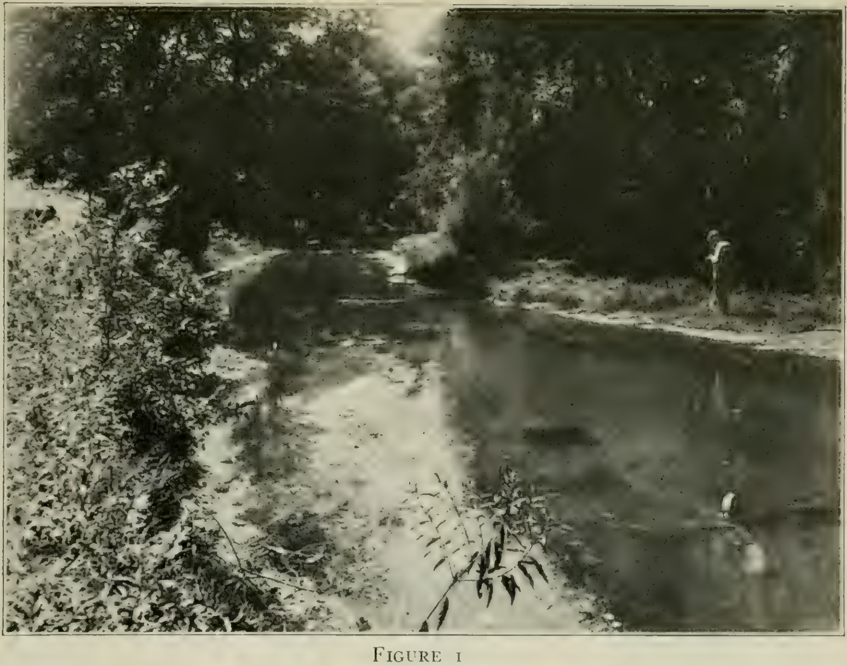

FIGURE 1

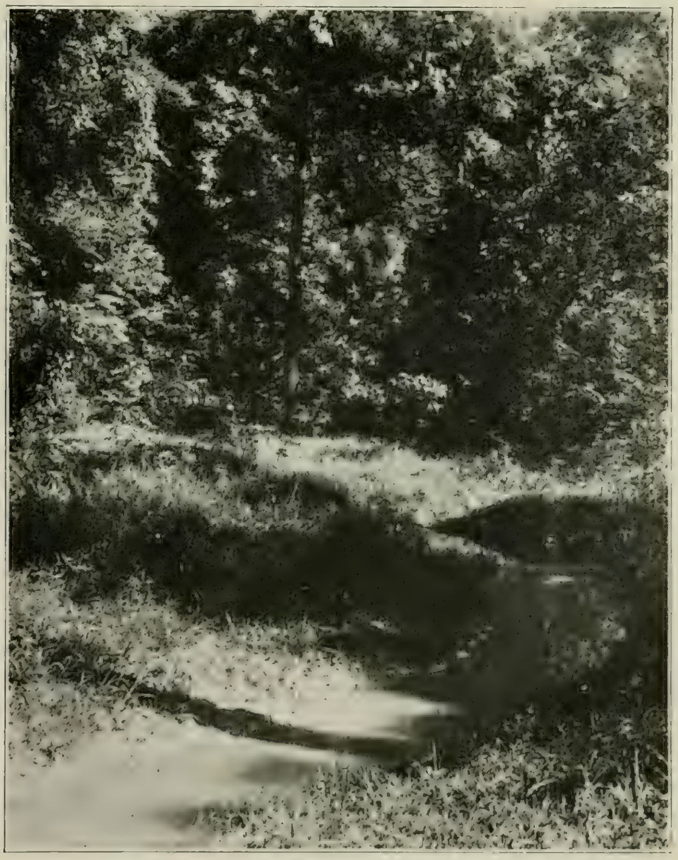

FIGURE 2

PLATE III

Station 25. Galien River in Warren Woods, with mouth of Sycamore Creek.

PLATE IV

FIG. 1.—Station 30. Galien River in Warren Woods, with log bridges.

FIG. 2.—Nest of *Hybopsis kentuckiensis* at Station 30, at low water.

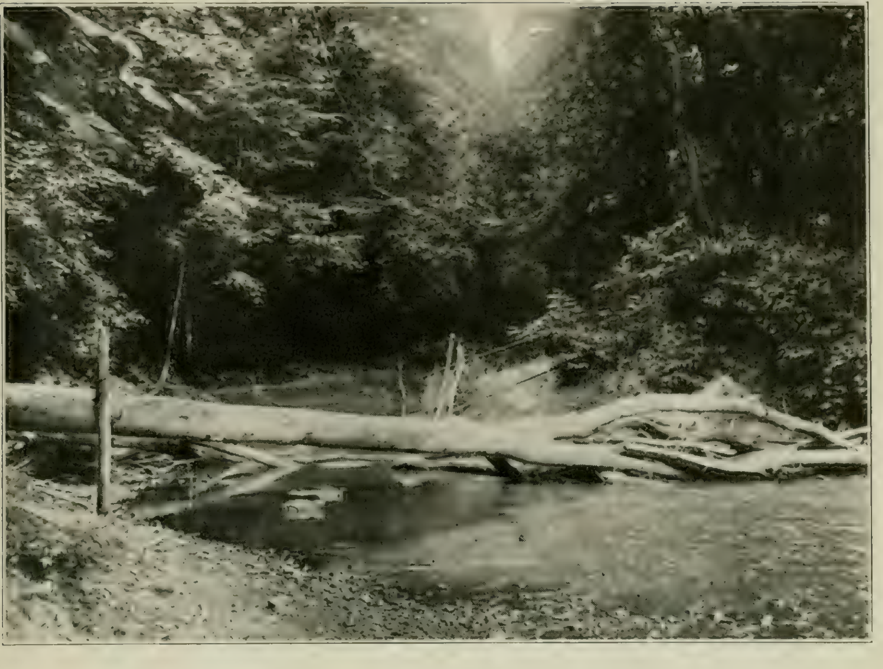

Figure 1

Figure 2

PLATE V

FIG. 1.—Station 46. A small, winding stream in a narrow, rather deep ravine in the north part of the Warren Woods.

FIG. 2.—Station 50. Galien River above bridge on main road through Warren Woods.

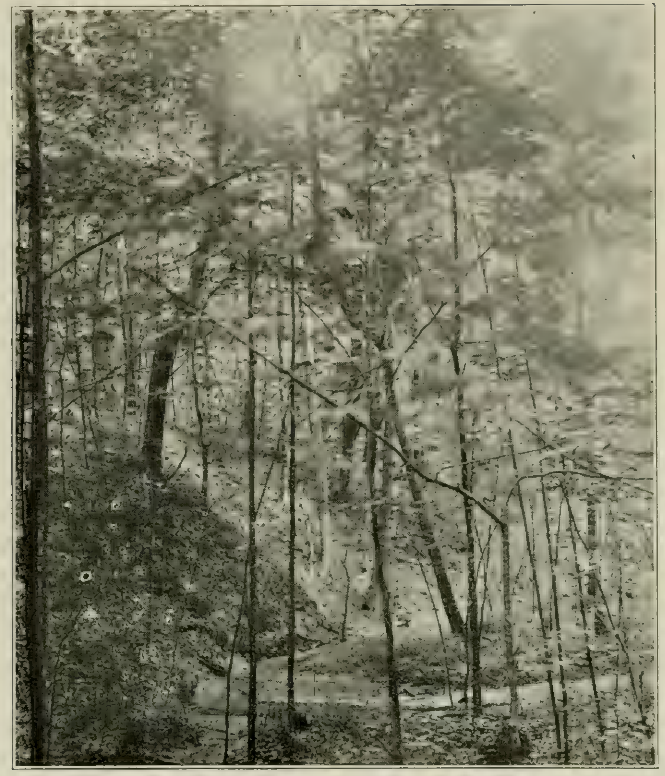

Figure 1

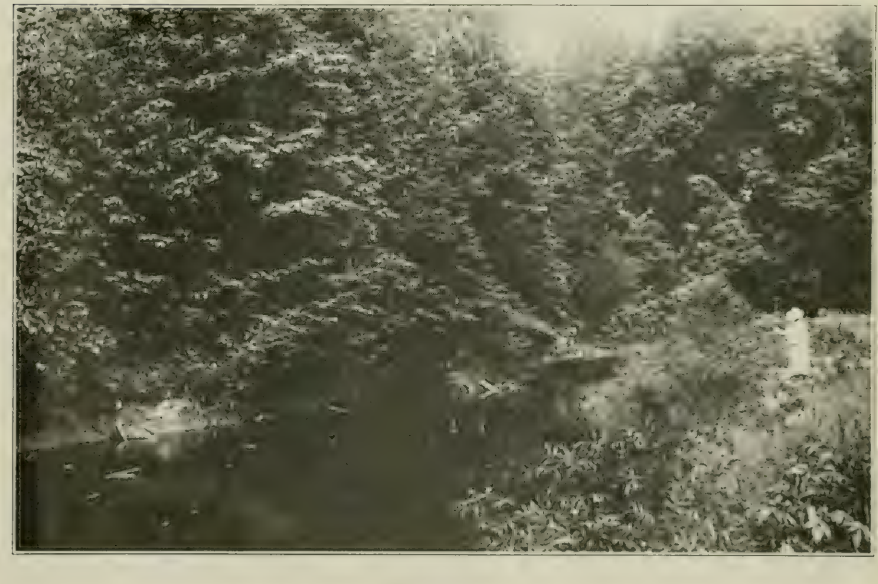

Figure 2

NUMBER 90 JULY 15, 1920

OCCASIONAL PAPERS OF THE MUSEUM OF ZOOLOGY

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A NOTE ON THE SYNONYMY OF THE CICHLID FISH OF CUBA AND BARBADOES, *CICHLASOMA TETRACANTHUS*

BY CARL L. HUBBS

Cichlasoma tetracanthus (Cuvier and Valenciennes)

Centrarchus tetracanthus Cuvier and Valenciennes *Hist. Nat. Poiss.*, VII, 1831, 460; Guichenot, in Ramon de la Sagra, *Hist..........Cuba, Poiss.* (1843), p. 31.

Acara tetracanthus Steindachner, Denkschr., *Wiss. Akad. Wien*, XXIII, 1864, 60.

Heros tetracanthus Jordan and Evermann, *Bull. U.S. Nat. Mus.*, Vol. XLVII, Part 2, 1897, p. 1539.

Heros tetracanthus tetracanthus Eigenmann, *Bull. U.S. Fish Comm.*, XXII, 1902 (1903), 230, Figs. 12, 13.

Cichlosoma tetracanthus Regan, *Ann. Mag. Nat. Hist.* (7), XVI (1905), 325.

Chromis fusco-maculatus Guichenot, in Ramon de la Sagra, *Hist..........Cuba, Poiss.* (1843), p. 78, Pl. 2, Fig. 3.

Acara fusco-maculata Günther, *Cat. Fish. Brit. Mus.*, IV, 1862, 282.

Heros fuscomaculatus Pellegrin, *Mém. Soc. Zool. France*, XVI, 1903 (1904), 227.

Acara adspersa Günther, *Cat. Fish. Brit. Mus.*, IV, 1862, 282.

Heros adspersus Pellegrin, *Mem. Soc. Zool. France*, XVI, 1903 (1904), 227.

Cichlosoma adspersum Regan, *Ann. Mag. Nat. Hist.* (7), XVI (1905), 324.

Heros tetracanthus torralbasi Eigenmann, *Bull. U.S. Fish Comm.*, 1902 (1903), p. 230, Fig. 11.
Heros tetracanthus griseus Eigenmann, *op. cit.*, p. 233, Fig. 14.
Heros tetracanthus latus Eigenmann, *op. cit.*, p. 234, Fig. 15.
Heros tetracanthus cinctus Eigenmann, *op. cit.*, p. 234, Fig. 16.
Heros nigricans Eigenmann, *op. cit.*, p. 235, Fig. 17.

Apparently more variable than most cichlids, the species inhabiting Cuba and Barbadoes has passed through a rather varied nomenclatural history. But before entering into a discussion of the several names which have been applied to this fish, we should consider the outstanding features of the variability of the species. To quote Eigenmann (p. 230), who has made the most extensive study of this form:

> Only a single species has been recorded from Cuba, and nothing has been said either concerning its distribution or its variation. No one, except possibly Poey, has before this compared numbers of specimens from different places or even from the same place. Such a comparison is therefore very desirable, and the material collected far surpasses all other collections made before. We have altogether 236 specimens from various localities. An examination of all of these proves either the presence of several instead of a single species in the island or a remarkable variation with localities. A definition of the variations has proved very elusive. The numbers of fin rays[1] and scales are uniform, so that the differences exist in the proportions and the color. But the coloration also has a certain underlying uniformity. There is a spot near the middle of the side, another at the base of the caudal, and an obscure third above the gill-opening. There are numerous small spots on the fins and on scales of the sides, especially below and on the opercles, and sometimes on the cheeks. There is also a longitudinal streak from the eye through the lateral spot to the caudal spot, and a definite number of crossbars, both streak and bars most conspicuous in the young and in light-colored adult individuals. This uniformity of underlying structure makes defining of species or varieties a difficult proceeding. The polymorphism is further complicated by instances like the following: The specimens from San Antonio are readily referable to a certain form found at Calabazar, although they differ from Calabazar specimens in quite readily distinguishable features; but one of them

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[1] Regan noted two specimens in which an unusually high number of spines was present in malformed (injured?) anal fins.

differs notably from all other specimens collected at San Antonio, and would unhesitatingly be considered a species distinct from the other specimens from the same locality. But at Palacios the same form branching from the Calabazar form approaches the characters of the single specimen from San Antonio.

In other words, the variations have at most an imperfect geographical significance. The variations in form possibly are sexual, for some large individuals are slender, while others are robust; the variations in color are perhaps in part correlated with sex, and imperfectly with age. Most of the variations, however, seem to be of an individual, rather than racial, sexual, or age, character.

Cichlasoma tetracanthus was described by Valenciennes in 1831, under the name of *Centrarchus tetracanthus*. Although Guichenot listed this name in 1853, he also described the species from Cuba, in the same work as *Chromis fusco-maculata*—a name later adopted by Günther and by Pellegrin. These two names were apparently based on similar examples of this variable cichlid, belonging to the type called *Heros tetracanthus tetracanthus* by Eigenmann. Eigenmann based five additional names upon Cuban cichlids, all of which Regan has synonymized, without remarks, with *tetracanthus*. These five nominal forms may be treated separately.

Heros tetracanthus torralbasi, as well as the type B and C of typical *tetracanthus*, seem to be based on individual modifications of the same fundamental color pattern. Both types occur together, and in specimens of either type the characteristic markings of the other show more or less distinctly.

Heros tetracanthus griseus is based upon one of the specimens from San Antonio with a comparatively large eye and gray, faintly marked coloration; the size of the eye falls well within the limits of variation ascribed to the species by Regan, and the coloration appears to be nearly matched by individuals of *tetracanthus* from other localities.

Heros tetracanthus latus, based upon a specimen from San Juan, appears to be characterized chiefly by the deep, compressed body (depth 2 in length to caudal); but Eigenmann records the depth in typical *tetracanthus* as varying from 2 to 2.7.

Heros tetracanthus cinctus and *H. nigricans* are based on dark adult individuals which show very distinctly the dark bars more commonly restricted to the young; both were taken with other individuals referred by Eigenmann to typical *tetracanthus*. As this author stated, the type and only known example of *nigricans* "is the most prominent of the aberrant forms"; in addition to the peculiarities of form and color, in which it is approached by other "subspecies," it lacks the pores in the posterior straight portion of the lateral line; the number of pores in this portion of the lateral line in other specimens varies widely, however (7 to 13), and only one specimen among eighteen taken at Pinar del Rio lacked these pores.

Unless further evidence of their distinctness is forthcoming, therefore, more than one form of cichlid can scarcely be recognized in Cuba.

Another nominal species may apparently be referred to the synonymy of *Cichlasoma tetracanthus*. This is *Acara adspersa* Günther, from Barbadoes, known only from a single specimen, re-described by Regan. The supposedly distinctive features of this form, as described by Regan, seem to be, however, all due to age variation (the type of *adspersum*, 218 mm. long; Regan's Cuban examples of *tetracanthus*, 64 to 154 mm. long). In the larger Cuban specimens described by Eigenmann, the snout (when 2.5 in head, the eye 5) is quite as long as the postorbital length of the head (suborbital not described by Eigenmann in large specimens, but doubtless wider than in those of medium size); the soft dorsal is produced "to near middle of caudal" (p. 233); the caudal peduncle may be quite as long as deep (cf. fig. 12). The supposed difference in the depth of the caudal peduncle was the only character used by Regan to distinguish the two forms in his synopsis of the species.[2]

The material of *Cichlasoma tetracanthus* examined by the writer consists of a set of Eigenmann's series from San Cristobal, San Antonio, Pinar del Rio, Calabazar, and Los Palacios, all in Cuba; also two from a small lake at Santiago de las Vegas and three from Calabazar, Cuba, collected by Mr. T. L. Hankinson.

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[2] *Ann. Mag. Nat. Hist.* (7), XVI, 1905, 66.

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